Volume 64 November 16, 1926 Number 20

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POWER

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Moments with the Ad Editor

The part which advertising plays . . . is that of education

President Coolidge

In his recent address to members of the American Association of Advertising Agencies, President Coolidge pointed out that advertising is the most potent influence in adapting and changing the habits and modes of life, affecting what we eat, what we wear, and the work and play of the whole nation.

"When we stop to consider," said President Coolidge, "the part which advertising plays in the modern life of production and trade we see that basically it is that of education. It informs its readers of the existence and nature of commodities by explaining the advantages to be derived from their use and creates for them a wider demand. It makes new thoughts, new desires, and new actions. By changing the attitude of mind it changes the material condition of the people.

"Somewhere I have seen ascribed to Abraham Lincoln the statement that 'In this and like communities public sentiment is everything. With public sentiment nothing can fail; without it nothing can succeed; consequently he who molds public sentiment goes deeper than he who enacts statutes or pronounces decisions. He makes statutes and decisions possible or impossible to be executed.'

"Advertising creates and changes this foundation of all popular action, public sentiment, or public opinion. It is the most potent influence in adopting and changing the habits and modes of life, affecting what we eat, what we wear, and the work and play of the whole nation. Formerly it was an axiom that competition was the life of trade. Under the methods of the present day it would seem to be more appropriate to say that advertising is the life of trade."

POWER

Volume 64 New York, November 16, 1926 *Number* 20

Making a Game of It

IT IS hard work to work hard.

But there is a lot of hard work done for fun.

If men in a gainful occupation were subjected even occasionally to some of the limits of physical endurance and mental stress to which they voluntarily submit in the name of sport, the world would echo with the taunt of slavery.

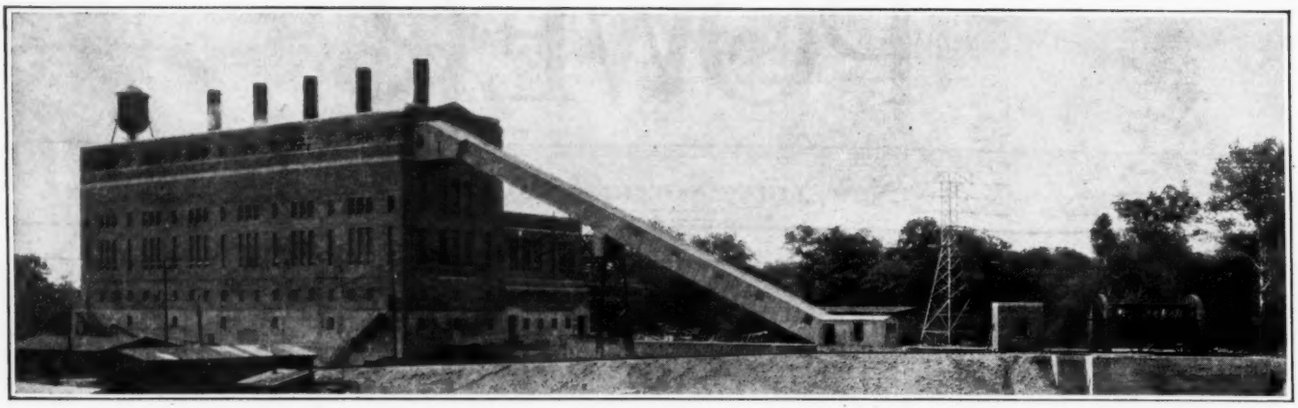
There is a lot of fun in work when one is really interested in it.

I do not see much chance for the mere laborer at a repetitive task that calls for nothing more than uninterrupted presence and manual dexterity to become enamored of his job.

The saving feature of such a job for a thinking man is that it calls for only physical service from him, and what the right kind of a man could do with his unoccupied mind during all those days and hours of humdrum application is a plenty.

But when the pace and the product are not set by the machine, when one has a chance to exercise some initiative and discretion and skill and ingenuity, especially when one is responsible for or credited with results, the day's work has in it all the elements of a contest or a tournament.

There can be as much interest in breaking the record with a boiler or a turbine as with a motor boat or airplane, and the arduous work of the fireroom may be turned into sport by inciting good-natured rivalry among different teams and bestowing adequate credit and recognition upon the winners.



New Picway station serving Columbus, Ohio

New Station at Columbus Embodies Many Refinements

PLANNED for an ultimate capacity of 150,000 kw., the new Picway station with an initial installation of two 30,000-kw. units, is provided with stoker-fired boilers capable of operating up to 450 per cent of rating. Motor-driven auxiliaries, bled steam, evaporators, preheaters and economizers are factors in the heat balance.

OWING to rapid growth and a decided upturn in industrial activity the demand for electrical energy in Columbus and vicinity had outstripped the generating capacity of the three plants of the Columbus Railway, Power & Light Co., serving the city. It became necessary to build a new station on a favorable site at the junction of the Scioto River and Big Walnut Creek, about twelve miles south of the city. Here the water supply is good, although, as the plant develops to its ultimate capacity, it may be necessary to place a dam across the river, and to conserve the supply during the summer months it is probable that spray ponds will be needed.

A feature will be an open canal extended from the end of the circulating-water discharge tunnel to Big Walnut Creek, with the object of avoiding troubles from ice by circulating the warm water from the condensers to the creek and back down the river to the plant.

All space east and south of the plant on the 240-acre site is available for coal storage. As the plant is in the middle of the central coal district of the state, it is probable that Ohio coal will be used, although comparisons have been made, including heat value, freight charges and the cost per ton at the mine, with West Virginia and Kentucky coals.

It is planned to maintain operation at about 300 per cent of rating with capacity to carry a load 50 per cent greater. Stokers longer than usual, designed to give uniform economy over a wide range of load, serve the boilers. To minimize the work required of the condenser and thus conserve cooling water, it was decided to bleed as much steam as possible from the main turbine. Motor-driven auxiliaries, therefore, are used in normal operation, with sufficient steam-driven auxiliaries in reserve for starting up the plant and for emergencies. The heat balance of the station is maintained by bled steam. Large economizers transfer the waste heat of the flue gases to the feed water, and a high-pressure evaporator gives the pure makeup necessary for boilers operating at high rating. The air for combustion is preheated by vapor from the high-pressure evaporators and the tenth-stage bleeder.

From a study of load conditions and the relative economy of different sizes of turbines it was decided that units of 30,000-kw. capacity at 80 per cent power factor would best meet the requirements of the plant under construction. Seventeen-stage turbines were selected. The steam conditions at the throttle are 335 lb. gage and 700 deg. F. total temperature Each machine drives directly a 14,000-volt 30,000-kw. three-phase 60-cycle generator, a 250-volt 160-kw. exciter and a 2,300-volt 1,200-kw. house generator on the end of the shaft. The curves show the thermal efficiency and the steam rate of the turbines at 1 and 2 in. of back pressure. It will be seen that the range over which high economy may be maintained is limited, but in a base-load plant that is not serious.

Each turbine has an individual system for oil purification, using a centrifugal purifier, with cross connections to permit any turbine operating on the oil purification system of any other turbine.

Cooling of the generators is done by air in a closed system provided with a cooler having main and auxiliary sections. Using condensate in the main section shows a gain of about 10 deg. in the feed water temperature. Circulating water is passed through the auxiliary section, which is equipped with thermostatic control that automatically places the auxiliary section in service when the air temperature reaches 100 deg. and cuts it out at 90 deg.

As an independent source of excitation an auxiliary geared-turbine-driven exciter of 200-kw. capacity has been provided. The two direct-driven house generators

supplying auxiliary power also are supplemented by a 1,250-kw. house turbine. With no independent supply outside the plant this reserve was considered essential, as it will be needed for starting or in the event of an accident to either one of the main unit house generators.

The Condensing Plant

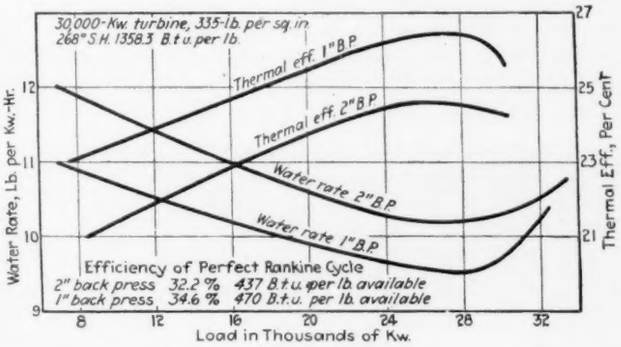
Each main unit is served by a horizontal two-pass surface condenser, bolted rigidly to the turbine base and supported on springs. Rubber expansion joints in the circulating-water lines provide the flexibility needed in the piping.

Two motor-driven circulating pumps, driven by 300-hp. variable-speed motors, serve each condenser. Ordinarily, one pump will meet the requirements and the two will be operated only when the load or the condition of the condenser surface makes it necessary. By adjusting the speed to the requirements, considerable saving in power is effected, the characteristic curves of the pumps showing that a drop in speed from 285 to 185 r.p.m. will save about 200 hp. Constant-speed squirrel-cage motors drive the condensate pumps, of which there are two per unit, of the vertical two-stage type. The vacuum is maintained by two batteries of steam-jet air pumps.

Circulating-water inlets consist of 5-ft. tubes worked into the concrete base of the building and terminating in concrete suction pits. Duplicate traveling screens are provided for each unit. The screenhouse is just large enough to accommodate four screens. It is topped by a flat concrete roof with a central hatchway and a steel structure above for hoisting the screens out of the pits. When the next two units are added, a duplicate screenhouse will be built opposite the units in question and a third one of half the size for the fifth unit.

An attractive and well-lighted boiler room has been obtained by placing the six boilers in a single row. The boiler design is unusual in that four longitudinal drums of 42 in. diameter supplant the usual cross-drum. Increasing the water storage and steam space in this way gave promise of reducing the fluctuations in water level to which boilers operating at high rating are subject.

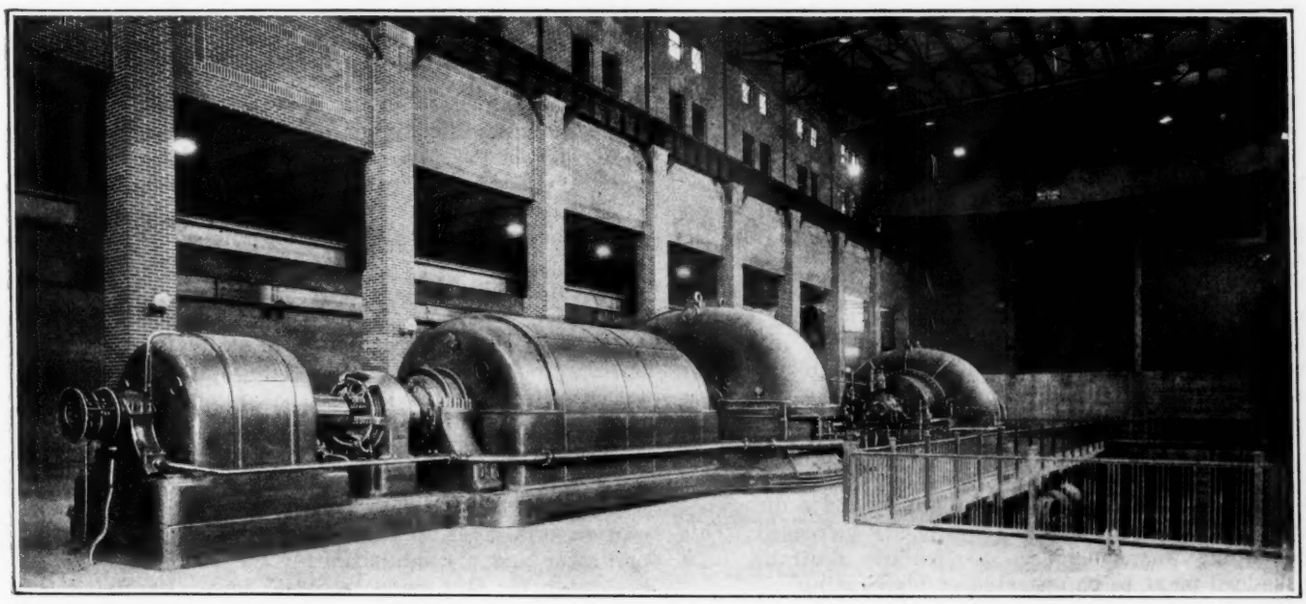
As the boiler proper is suspended from the building steel at the front and from stub columns at the rear, the setting consists of thin firebrick walls, supported by a frame of vertical I-beams with horizontal stiffeners. To the outer flanges of these I-beams ½-in. plate is



Thermal efficiency and water rate of main turbine

secured to form vertical 12-in. air ducts between the plates and the brickwork, through which all air for combustion is drawn. On either side of the setting are seven of these ducts with dampers at the top, set by hand to give uniform air temperature at the boiler-room floor line. The supply is admitted through small windows at the top of the boiler house and is drawn down around the economizers to the ventilated walls of the boilers, collecting in its passage the radiated heat from the boiler equipment.

From the ventilated walls of the boilers the combustion air is drawn down into an airtight room in the basement in which are all the forced-draft fans. One fan is provided per boiler, and ordinarily each will supply its individual unit, but all discharge into a common duct which is sectionalized so that an interchange of service is possible. The drive is a variable-speed, direct-connected motor, with push-button motor-driven control. Here again power may be saved by reducing



Two 30,000-kw. units in turbine room

the speed should the boiler be carrying less than its usual load.

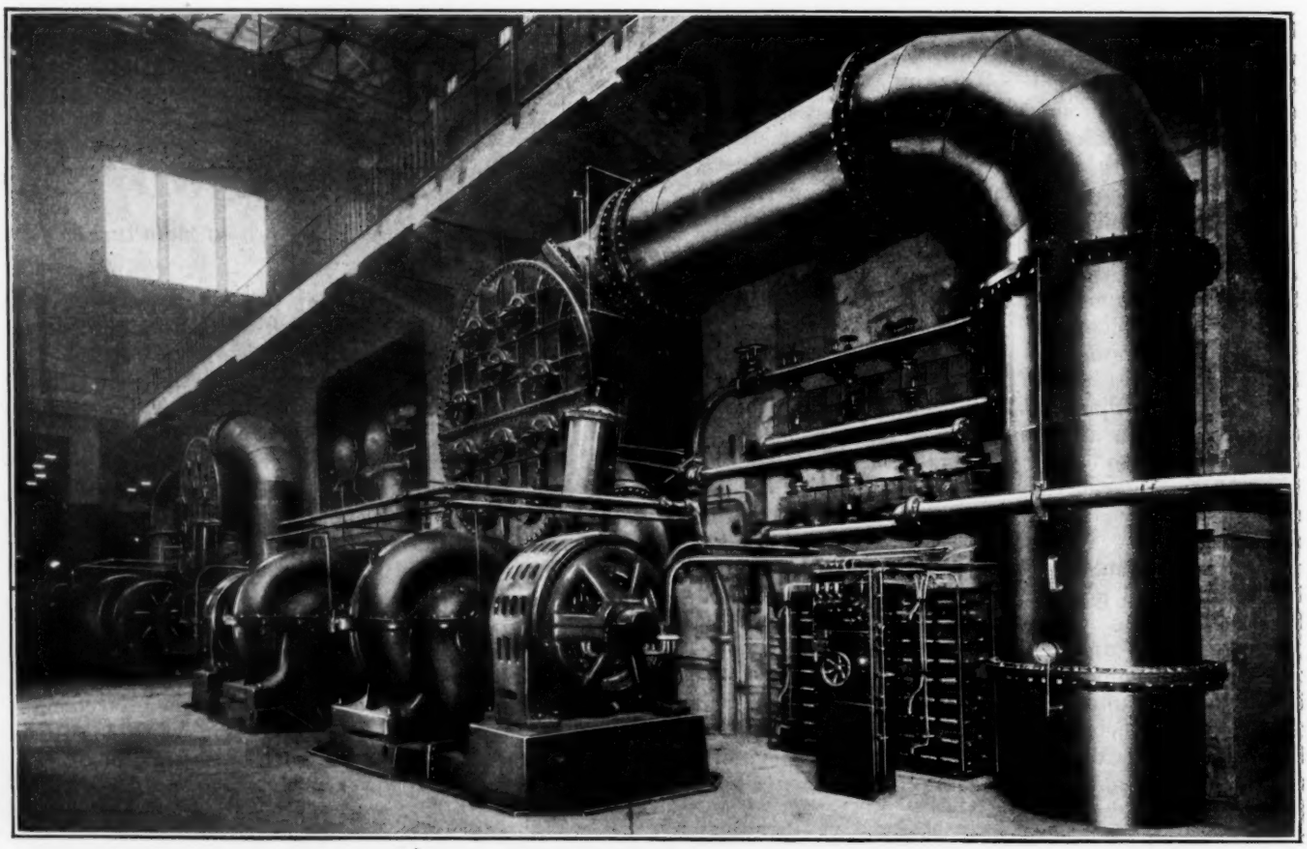
Between each fan and the windbox of the stoker is a fin-type heater, using bled steam from the main turbine and vapor from the high-pressure evaporators to preheat the combustion air from a temperature of 117 deg. F. reached in the ventilated setting walls to 245 deg. F. for delivery to the stoker. These temperatures apply to summer conditions and are obtained by the use of steam at 50 lb. abs. pressure.

Over each boiler is its induced-draft fan, which draws the gases through the uptake to the top of the economizer and then down over the surface to discharge them directly into a steel stack supported on the reinforced fan casing. The stacks are 78 in. in diameter, rise 60 ft. above the fan and, to stabilize against wind pressure, are guyed at four points.

A complete study of stokers for the size of boilers installed and the coal to be burned resulted in the selection of underfeed stokers of a size larger than had been in use. The extra length provided in a twelve-retort stoker, 41 tuyeres long gave a grate long enough to permit complete combustion of the carbon in the ash before the refuse is dumped over the back plates to the clinker rolls. Comparative tests of the 41-tuyere stoker with the 11- or 12-retort 37-tuyere stoker that had been in use, showed a combined boiler, furnace and stoker efficiency at 250 per cent of rating at least 6 per cent higher for the large stoker and a difference in economy greater still as the capacity increased. This advantage was considered particularly desirable in a base-load plant to be operated at high rating.

Results from recent experiments made by the company in removing clinker and ash from Western coals, made it seem desirable to increase the diameter of the clinker rolls from the usual 10 in. to 18 in. It had been apparent that the smaller rolls were not large enough to grab a good-sized clinker and pull it through the dump pocket. Also, it had been found desirable to cool the clinker as much as possible before it came in contact with the rolls, so it would be brittle and break up readily instead of being pulled away a little piece at a time by the rolls. To do this a water spray was installed in the fish-scale back plates, above the clinker rolls, to provide just enough water to chill the clinker.

The ashpit is of concrete construction, lined with paving brick. Each pit is provided with three gates, operated hydraulically by oil pressure supplied by a motor-driven gear pump, equipped with a relief valve and bypass opening at 80-lb. pressure.



Condensers and auxiliaries in turbine-room basement

All six boilers are connected into a 20-in. welded steel header sectionalized at the center so that the three boilers per turbine may be operated as a unit, or a sufficient number of boilers in unison to supply the two machines.

In the high-pressure piping all the valves are hand operated. A feature is the general use of ball-and-socket joints. Expansion of the piping is cared for by expansion loops and bends. The support in general is from spring hangers. To indicate the service a color scheme for the piping has been adopted.

To conserve the waste heat in the flue gases, consideration was given to the use of an economizer, an air preheater and a combination of the two. However, a preheater for this purpose would have eliminated one effective use for bled steam, even though the gain in

economy compared favorably with that obtained from an economizer. The combination of the two would have introduced complications, particularly in the duct work, and with the preheater after the economizer, the rise in air temperature would have been comparatively small. As the best solution for the conditions to be met, it was decided to install an economizer with large surface, which under normal operation would reduce the flue-gas temperature to about 350 deg. F., and to use steam from the turbine for the preheating of the combustion air.

Steam is bled from three stages of the turbine—from the tenth stage at a shell pressure of 50.5 lb. abs. for preheating combustion air, and from the twelfth and fourteenth stages at 22.5 lb. and 6.8 lb. abs., respectively, for heating the feed water. These pressures pertain to an average operating load of 25,570 kw. assumed in a typical heat balance. The low-pressure bleeder leads to the fourteenth-stage closed heater and the intermediate line to the twelfth-stage open deaërating heater. In the former the temperature of the condensate is raised 54 deg., and in the open heater it reaches 204 to 210 deg., this temperature being maintained by the use of a pressure regulator in the twelfth-stage bleeder line. To speed up deaëration of the water in the open heater, a vacuum corresponding to the temperature of the water is maintained on the heater by the use of a steam-jet air pump with suitable inter- and after-condenser for cooling the vapors carried over with the air.

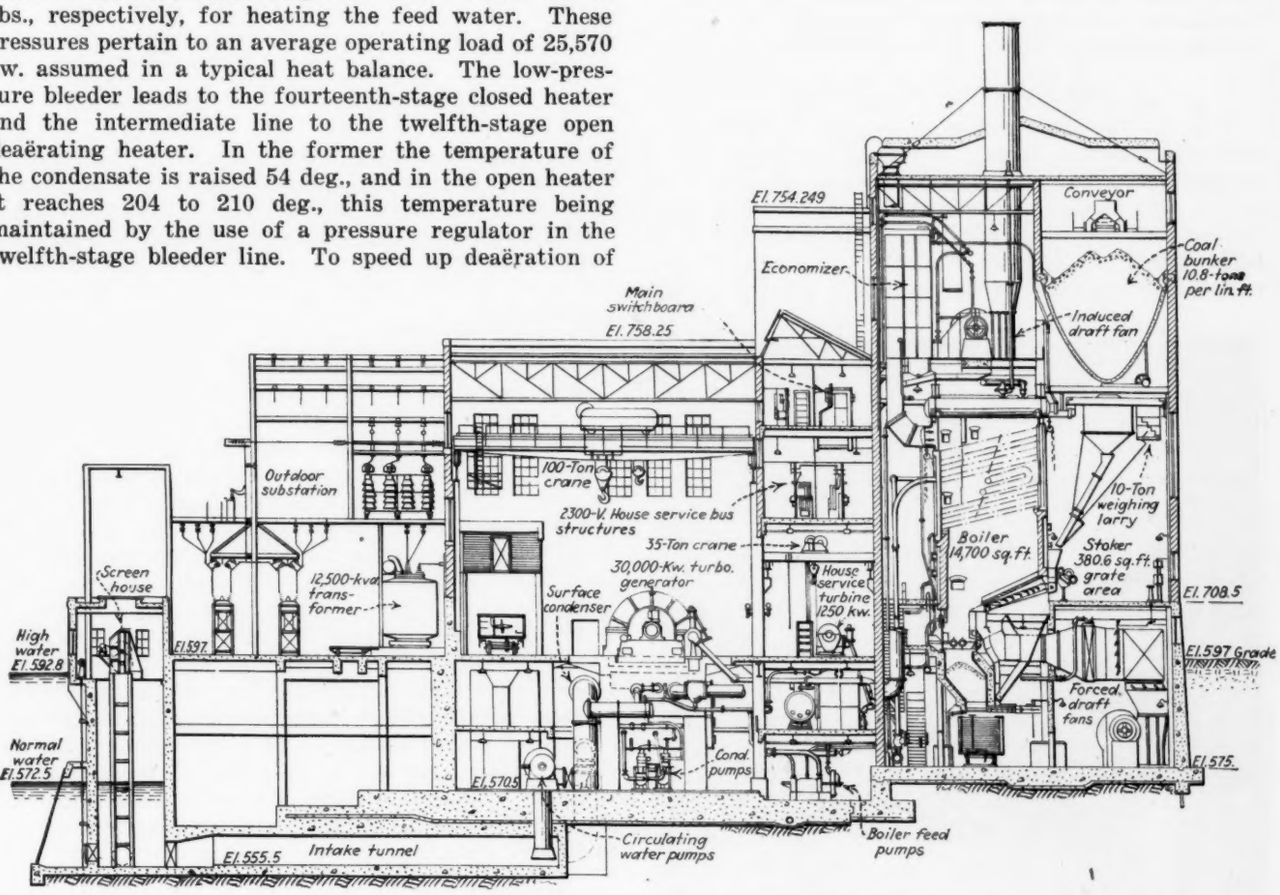
From the open heater the feed water goes to the boiler-feed pumps, of which there are four, two motor-driven and two turbine-driven, each of 650 gal. per min. capacity. Thus, a provision of two pumps per unit is made and all are interconnected. There will be times when one pump will supply the service, such as when only one of the main generating units is running. The pumps discharge the feed water through steel-tube economizers into the boilers at a temperature of 332 deg. F., under the operating conditions assumed in the heat balance previously mentioned.

Interconnected duplicate headers make it possible to bypass any portion of the boiler-feed piping. Improved type feed-water level regulators are in use and at every boiler a pressure differential regulator, the latter assisting the former in maintaining a flow following uniformly the output of the boiler.

High-Pressure Evaporator

Operation of the boilers at high rating called for pure makeup water, and a survey of methods prompted the installation of evaporators. Consideration of the use of bled steam in the evaporators showed that the equipment would not be flexible in operation, that at times the capacity of the evaporator would be reduced seriously, and likewise the quantity of steam that could be bled from the lower stages of the turbine for feed-water heating. Besides, it would be necessary to condense the vapor from the evaporator in the open feed-water heater, as its temperature would be too low for use in the air preheater. Therefore, the equipment installed for each unit was a high-pressure two-effect evaporator, with a raw-water preheater, suitable for evaporating 11,000 lb. of water per hour. The raw-water supply is taken from the discharge of the auxiliary section of the generator air cooler to take advantage of about a 20-deg. rise in temperature. The vapor from the evaporator is condensed in the air preheater and the condensate drains to the twelfth-stage open feed-water heater.

Computations in a typical heat balance with two boilers on the line operating at 312 per cent of rating, show the B.t.u. consumption per net kilowatt-hour at



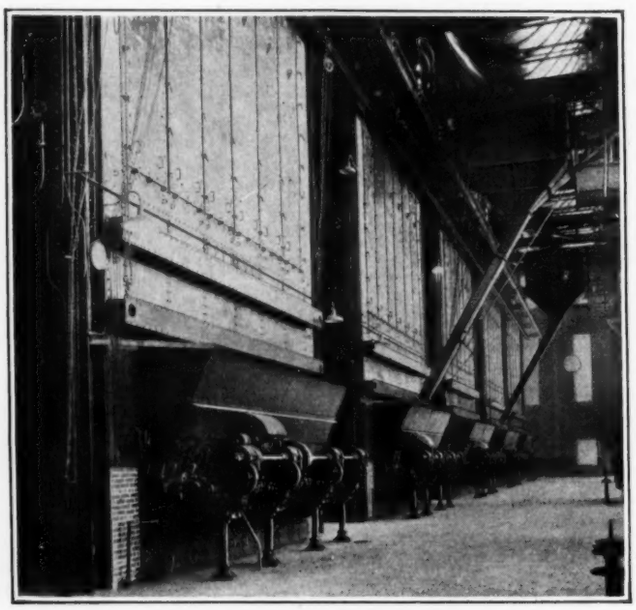
Transverse section through basement

a 28-in. vacuum, to be 16,566. At 29-in. vacuum the economy would be somewhat better.

A feature of the station is an auxiliary bay to house the various auxiliaries such as the feed-water and service-water systems, the evaporators, the house service turbine, the steam-driven exciter, and on the floors above, the main switching and control boards as well as the house service bus structure. Placing the pumps in line, with the heaters in close proximity, and suspending the headers from the ceiling beams where they are readily accessible, makes an ideal arrangement. The various piping connections are short and regular in arrangement and the appearance generally is attractive. Besides, this arrangement relieves congestion in other parts of the station, so that the absence of the usual mass of piping and the miscellaneous spacing of auxiliaries not only facilitates operation, but adds to the attractiveness of the plant as a whole.

Car Dumper Unloads Coal

Coal for the plant comes in by rail over railway or interurban electric lines. Unloading is done by a car dumper into a track hopper from which the coal is fed into a rigid-hammer crusher and discharged to a 36-in. inclined belt conveyor rising gradually to the top of the boiler room. Delivery is made by a traveling tripper to the overhead steel bunker, which is 217 ft. long and



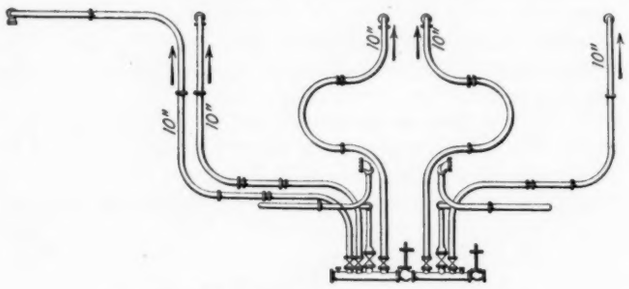
Firing aisle in boiler room

has a capacity of 10.8 tons per lineal foot. Either one of two 10-ton traveling weigh larries, electrically driven, transfer the coal to the stoker hoppers. Locomotive cranes unload to or reclaim from open storage.

Auxiliary Power

Primarily, power for the station comes from the auxiliary generators driven by the main turbines. Each generator delivers to a separate section of the 2,300-volt auxiliary bus from which the essential auxiliaries for that unit are supplied. The emergency house turbine unit delivers to either section of the bus. The usual arrangement of duplicate buses and a transfer bus is provided.

With one exception all motors 50 hp. and above are designed for 2,300 volts. All the smaller motors operate at 220 volts and are supplied through transformer banks with primary connections to the auxiliary bus. Most of the motors are remote controlled by push button. All the 2,300-volt motors have their primary breakers mounted in the house-service switch structure to eliminate high-voltage switching equipment near the



Plan of high-pressure steam piping

point of control and thus safeguard the operator. Primary switches for the 220-volt motors are practically all of the magnetic contactor type. Complete control for the motors driving the stokers and fans for each group of two boilers is centered on control boards of three panels, which also carry the boiler-room instruments.

Electrical Equipment

Each main generator, a three-phase 60-cycle 14,000-volt 37,500-kva. machine, connects directly with an individual transformer bank stepping up the generator voltage to 39,400 volts before delivery is made through oil circuit breakers to the main bus. Synchronizing of the main generator is done on the high-tension side of the transformer. Straight, double-bus construction, with two breakers per generator or outgoing line, is used.

The main buses are in the outdoor substation along with the main generator transformers and the high-tension switching equipment. To avoid excessive cost of substructure, it was necessary to cut down the area occupied by the substation to a minimum. To this end outgoing lines had to be taken off the end of the structure rather than from the sides, involving some unusual features in the structural arrangement as well as in the electrical connections.

Separate Office Building Made Entrance to Plant

A feature not often given the attention it deserves is the location of an office building across the permanent end of the turbine room to give a central point through which all employees must enter and from which there is access by elevator or stairs to all parts of the plant. This arrangement gives convenient access to the plant and brings all branches of the operating force in closer contact.

As is usual in all new plants built by the holding company, the engineering and construction work has been carried out under the immediate supervision of B. J. Denman and G. T. Shoemaker, president and vice-president, respectively, of the United Light & Power Engineering & Construction Co., with headquarters in Davenport, Iowa. Operation is under the direction of C. C. Slater, vice-president and general manager of the Columbus Railway, Power & Light Company.

PRINCIPAL MECHANICAL EQUIPMENT OF PICWAY STATION

Ultimate Capacity, 150,000 Kilowatts

GENERAL

Location of plant	12 miles south of Columbus, Ohio
Capacity present building, kva	75,000
Boiler-house floor area, ft.	58x252
Auxiliary bay, ft.	24x200.5
Turbine room, ft.	60x200.5
Office and storeroom, ft.	24x84
Width of firing aisle, ft.	25

BOILERS AND SUPERHEATERS

Type and number	Six B. & W. longitudinal, four-drum
Steam-making surface per boiler, sq.ft.	14,700
Ratio steam-making surface to grate area	38.6 to 1
Furnace volume, cu.ft.	6,000
Sq.ft. steam-making surface per cu.ft. furnace volume	2.45
Cu.ft. of furnace volume per sq.ft. projected grate area	15.75
Boiler-operating pressure, lb. gage	350
Superheat, deg. F. at 200 per cent rating	270
Total steam temperature, deg. F.	710
Type of superheaters	Convection
Superheater surface per boiler, sq.ft.	3,050
Ratio, superheater surface to steaming surface	1 to 4.8
Location of superheaters	In first pass, above sixth row of tubes
Boiler-setting height	18 ft., with firing from high end
Soot blowers	Vulcan 22 heads per boilers

ECONOMIZERS

Type and number	Five B. & W. steel, counterflow
Surface, sq.ft.	9,655
Ratio, boiler-heating surface to economizer heating surface	1.52 to 1

STOKERS

Type and number	Five Taylor underfeed
Size	12 retort, 41 tuyere
Projected grate area, sq.ft.	380.6
Clinker-grinder drive for stoker	Two 3-hp. single-speed G. E. squirrel-cage motors, 1,200 r.p.m.
Stoker drive	10-hp. G. E. motor
Furnace width, ft.-in.	20–10

FORCED DRAFT FANS

Number and make	6 Jeffrey
Capacity	75,000 c.f.m. at 70 deg. F., with 7½-in. static pressure
Drive	150-hp. wound-rotor. motor
Control	Push button, pilot motor and drum controller

INDUCED DRAFT EQUIPMENT

Number and type	5 Jeffrey
Size	6x3 ft., double-inlet, top vertical discharge
Capacity	160,000 c.f.m. against suction press. of 6 in., temp. 450 deg. F.
Drive	100-hp. wound-rotor motor and 250-hp. squirrel-cage motor
Full load speed of 100-hp. motor, r.p.m.	425
Full load speed of 250-hp. motor, r.p.m.	585
Control for slip-ring motor	Push button, pilot motor and drum control
Control for 250-hp. motor	Oil circuit breaker (full voltage)

STACKS

Number and make	5 Pittsburgh-Des Moines Steel Co.
Support	On reinforced induced-draft fan casing
Height above fan, ft.	60
Diameter, in.	78

BOILER FEED PUMPS

Number and make	4 De Laval
Type	Two 5-stage, two 6-stage cent.
Capacity, gal. per min.	650 against 980-ft. head
Drive—2 pumps	250-hp. squirrel-cage motors
Drive—2 pumps	250-hp. Terry steam turbines

HOUSE SERVICE PUMPS

Two	De Laval
Type	Two single-stage De Laval 200 g.p.m., against 140-ft. head
Type	One Dayton Dowd, 182-ft. head
Drive of all pumps	Motors

HEATERS

Per unit	2 Cochrane
Type	One closed, one open deaerating heater per unit
Capacity per unit, lb. per hr.	350,000

EVAPORATORS

Per unit	2 Griscom-Russell
Type	High-pressure, double-effect
Normal capacity per unit, lb. per hour	11,000
Evaporator feed-water heater	Vertical cast-iron type, low-presurse
Capacity, lb. per hr.	12,000
Rate, deg. F.	From 80 to 210

HIGH-PRESSURE PIPING

Main and Auxiliary Steam and Boiler Feed.

Lap-welded pipe with cast-steel flanged fittings designed for 400 lb. pressure and 750 deg. temperature. All flanges on the lap-welded pipe are forged steel. Headers are electric welded and reinforced with gas-welded gusset plate. All high-pressure joints are Midwest ball-and-socket type. Sizes 2-in. and under have threaded joints and forged steel fittings. These joints are welded where necessary. Pipe fabricated by Crane Company and Midwest Piping & Supply Co. Special steel alloy stud bolts used throughout.

LOW-PRESSURE PIPING

Atmospheric relief	Wheeler Condenser & Eng'ing Co.
Non-return valves in bleeder lines	G. M. Davis Regulator Co.
Boiler blowoff valves	Everlasting quick opening valves and B. & W. angle valves
Cir.-water valves, 36-in. gate	Chapman Valve Mfg. Co.
Main steam valves	Lunkenheimer Co.
Drum-head stop check valves on boiler feed	Edward Valve & Mfg. Co.

COAL HANDLING SYSTEM

Manufacturer	Jeffrey Manufacturing Co.
Capacity, tons per hr.	250
Crusher	Jeffrey rigid hammer
Car dumper, 100-ton car	Link-Belt Co.
Bunker, 2,400 tons	Brown Hoisting Machine Co.
Traveling weight larries, two	Jeffrey 10-ton
Yard storage, tons	200,000
Method of reclaiming coal, 100-tons per hr.	Locomotive Crane

ASH HANDLING EQUIPMENT

Ash per boiler hopper, cu. ft.	1,200
Gates, hydraulically operated	Allen-Sherman-Hoff Co.

MAIN GENERATING UNITS

Manufacturer	General Electric Co.
Type	Single-cylinder, stage bleeder
Machine bled at	10th, 12th and 14th stages
Steam pressure at 10th stage with normal load, lb. abs.	52
Steam pressure at 12th stage with normal load, lb. abs.	24
Steam pressure at 14th stage with normal load, lb. abs.	7.6
Number of stages in turbine	17
Rated capacity of turbine at 80 per cent p.f., kw.	30,000
Generator	14,000-v. Y-connected 3-ph., 60-cycle
Generator ventilation	G.E., U-Fin coolers in two banks
Cooling air, cu.ft. per min.	90,000
Cooling water	Condensate through main bank; circulating water through secondary bank
Quantity circulating water, g.p.m.	0 to 900
Highest allowable temperature leaving cooler, deg. F.	96
Direct-connected house generator on main unit shaft	1,200 kw., 2,300-v. 3-ph. 60-cycle.
Direct-connected exciter	160 kw., 250-v.
Turbine lubrication	One geared pump and one turbine-driven auxiliary pump with automatic pressure control
Oil cooler, No. 19-A 12	Andale Engineering Co.
Auxiliary exciter	200-kw., 250-v.

CONDENSING EQUIPMENT

Manufacturer	Wheeler Condenser & Eng'ing Co.
Type	Horizontal, 2 pass.
Tube surface, sq.ft.	40,000
Connection to turbine	Rigid
Supported on	Springs
Circulating pumps	Two, 36-in. d.s. cent., 40,000-g.p.m. when operated singly and 52,000-g.p.m. when operated together
Pump drive	300-hp. variable-speed motor, arranged for 30 per cent speed reduction
Vacuum pumps	Two Wheeler steam-jet pumps with inter- and after-condenser for each unit arranged for cooling by condensate
Condensate pumps	Two 5-in. 2-stage, 650-gal., 158-ft. head vertical pumps for each unit.
Oil-purifiying equipment	Two No. 600 centrifugal oil-purifying units with 2,000-gal. oil-storage tank and suitable pumps for handling the oil—De Laval Steam Turbine Co.

MISCELLANEOUS EQUIPMENT

Air compressor, 300 cu.ft. 90 lb.	Westinghouse Air Brake Co.
Turbine room crane, 100 ton, 4-motor	Whiting Corporation
Auxiliary bay crane, 35 ton	Case Co.
Boiler and economizer soot blowers	Vulcan Soot Blower Co.
Pressure differential regulators	Mercon Regulator Co.
Feed-water regulators, Copes	Northern Equipment Co.
Structural steel	Pittsburgh Des Moines Steel Co.
Duct work	Littleford Brothers
Sluice gate	Coffin Valve Co.
Revolving screens	Chain Belt Co.
Electrical switching equipment	General Electric Co.
Boiler instruments	Bailey Meter Co., Foxboro, Co., American Schaffer & Budenberg Corp., Taylor Instrument Co.'s

The Still Oil-Steam Engine in Practice

WHEN the use of the Scott-Still Diesel-steam engine was proposed, much criticism was voiced as to the probable operating difficulties. In the face of the uncertainties attending a new design the owners of the vessel "Dolmus" proceeded to install two four-cylinder engines of this Diesel-steam design of a total capacity of 2,500 hp. This motorship has been in the round-the-world service sufficiently long to prove that the expected difficulties will not assume tangible form.

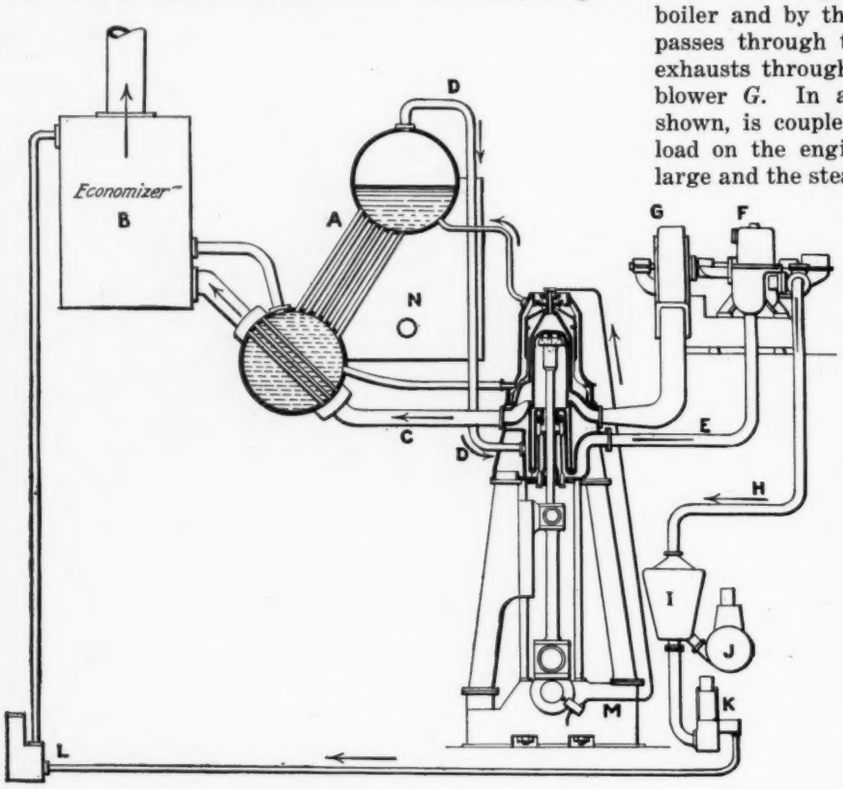


Diagram of the Still-Engine installation on the "Dolmus"

Each of the Scott-Still engines of the "Dolmus" has four two-stroke-cycle Diesel cylinders of 22-in. bore and a stroke of 36 in. The lower ends of the cylinders are inclosed and are used as the steam portion of the unit. The steam-cylinder bore is the same as is the upper, or Diesel, end, but the effective piston area is reduced by the piston rod by about 10 per cent. The steam leaving the steam cylinder passes to a low-pressure turbine which drives the scavenging air blower. The engine's steam back pressure is about 19-in. vacuum and the turbine exhausts into a 27-in. vacuum. About 14 per cent of the total power output is delivered by the steam units. A diagrammatic outline of the Still system on the "Dolmus" is shown in the illustration.

One special boiler *A*, consisting essentially of one-half of a Yarrow water-tube boiler, has its lower drum provided with a nest of tubes through which the exhaust gases from the oil engines pass. An economizer or pressure closed heater *B* is interposed between the boiler and funnel. The engine jacket is connected to the boiler drums and is under the boiler pressure of 135 lb. and the boiler feed is drawn from the hotwell *K* by the pump *L* and delivered against boiler pressure into the economizer *B*, which in turn discharges into the lower boiler drum.

The steam generated by the exhaust gases in the boiler and by the heat transfer in the cylinder jacket passes through the pipe *D* to the steam cylinder and exhausts through *E* to the turbine *F* which drives the blower *G*. In addition to the turbine, a motor, not shown, is coupled to the blower shaft. With a heavy load on the engine the heat given up to the boiler is large and the steam cylinder's terminal pressure is high. This permits the turbine to drive the blower with the motor idling. With a low engine load, the turbine's initial steam pressure is lower and the turbine slows down enough to cause the motor to assume part or almost all of the blower load.

The Diesel's cast-iron cylinder liner is thin, approximately ⅝ in., and is provided with heavy fins upon which a steel hoop has been shrunk. The jacket-water temperature is in the neighborhood of 360 deg. F., and the thin liner permits a rapid heat transfer. The jacket pressure lowers the tensile stress set up in the hoop by the internal gas pressure. This means that the outer jacket wall bears a portion of the radial gas pressure.

The line *C* is provided with a non-return valve, the intention being that this would close in case of trouble with the boiler and so prevent the jacket from being emptied. This safeguard has proved to be an unnecessary and dangerous piece of apparatus, for on one occasion, by closing unexpectedly, the jackets were emptied owing to steam action. Four liners were fractured, but fortunately it was possible to continue operating with three of these, the fracture being far down along the stroke. It was feared that the gas tubes in the lower boiler drum would give trouble, but this has not materialized. Neither has the pressure economizer caused any difficulty, although the feed pump had not been perfect in its functioning.

The valves of the steam end are of the poppet type and are operated by a hydraulic pressure gear. This has met the most sanguine expectations and has caused no trouble.

The oil for the Diesel end of the cylinders is handled on the solid-injection principle. The compression pressure is approximately 330 lb. per sq.in. This might be too low for starting if it were not for the presence of the steam cylinder. In starting the engines, the oil burner *N* under the boiler is started and steam pres-

sure raised. The warm piston and jacket so raises the cylinder air temperature that the oil end fires on the first injection of fuel. After development work is completed, the cost of installation should not greatly exceed that of the ordinary Diesel, although the cost of the "Dolmus" units is reported to have been $500,000 for the 2,500 hp.

About 14 per cent of the engine's output is developed by the steam generated from the heat in the exhaust and in the jacket, making it apparent that the steam mean effective pressure is low. For stationary plants it has been suggested that the Still engine has an application in cases where peak loads are common. By utilizing the boiler burner, a large amount of steam could be generated and a longer cutoff used, even at a sacrifice of thermal efficiency.

1,250-Degree Steam for Process Work in France

By R. H. Andrews
Paris Representative of *Power*

POWER-PLANT practice is evidently preparing for an important jump in steam temperatures, and two European stations have already experimented with temperatures reaching 850 deg. or more at the turbine throttle. But many experts are still doubtful as to the strength and general behavior of metals at these temperatures, particularly in the turbine and the superheater.

In this respect, it should be remembered that many industrial processes are far in advance of central-station practice, in the use of high steam pressures and temperatures, and that information can be collected in this field that would be invaluable to the power field.

Some processes use high pressures alone, others high temperatures alone, while a few use the two combined. The photograph shows a 2,500-sq.ft. superheater recently built in France by the Compagnie des Surchauffeurs to deliver low-pressure steam at 8 lb. per sq.in. and 1,100 deg. F. It has now been in continuous service for several weeks, during which period the steam temperatures have been held between 1,100 and 1,250 deg.

Factors That Determine Ability of a Metal to Withstand High Temperatures and Pressures

Three principal factors determine the ability of a metal to withstand high steam temperatures and pressures in superheater construction: First, the mechanical strength of the metal at high temperatures, upon which depends its resistance to distortion or rupture under pressure; secondly, the resistance of the metal to oxidation on the outside, by contact with the furnace gases; thirdly, its resistance to oxidation on the inside, through partial decomposition of the steam in the presence of hot iron.

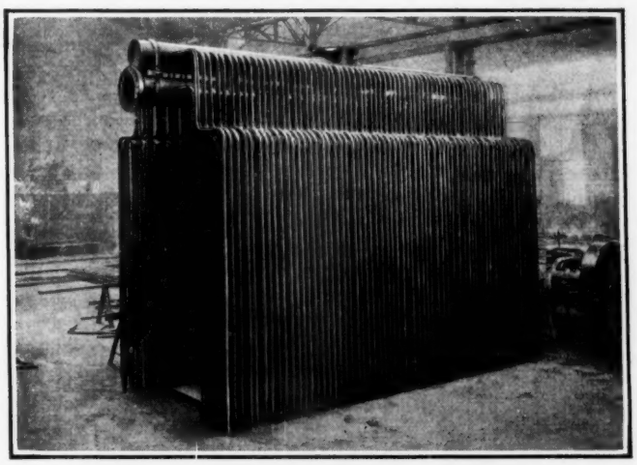
The behavior of this 1,200-deg. superheater in practical service will be useless to the power field, as regards the mechanical resistance of the metal, owing to the extremely low steam pressure for which it is designed. But its indications regarding the resistance of the metal to internal and external oxidation should be very valuable for in both respects the working conditions of the metal are particularly exacting.

It is considerably more difficult to reach a high temperature with low-pressure steam than with high; and, for a given final steam temperature, the metal of the superheater tubes will be materially hotter with low-pressure steam than with high. This is due to the three following causes, all tending to reduce the coefficient of heat transfer from metal to steam:

1. Owing to the greater specific volume of low-pressure steam, a given amount of heating surfaces comes in contact with a much smaller weight of steam per second, and therefore gives up less heat per second with the same temperature difference.

2. The velocity of steam flow through the tubes must be kept very low with low-pressure steam, because the pressure drop available to force the steam through the superheater is much less than with high-pressure steam.

3. Superheated low-pressure steam is nearer a perfect gas in its physical structure and properties than high-pressure steam at the same total temperature; and



This low-pressure superheater is delivering steam at over 1,200 deg.

the coefficient of heat transfer from metal to gas is always lower than that from metal to vapor.

These three conditions reduce the coefficient of heat transfer from metal to steam. The result is to make a higher temperature drop necessary from metal to steam, in order to transmit the same amount of heat. The metal must therefore be hotter with low-pressure than with high-pressure steam.

A New Record in Boiler Operation

One of the large central-station companies engaged in central district heating has successfully operated a large boiler at 5 per cent of its nominal builder's rating, without any changes in the furnace or stoker or auxiliary equipment. The underfeed stoker was operated intermittently, and natural draft furnished by the stack was the sole means of supplying air to the fire. The minimum operating capacity of the boiler-feed pump was far greater than 5 per cent of boiler rating, and hence the pump also was operated intermittently, raising the water level well up in the gage glass and stopping the pump until the level had fallen somewhat.

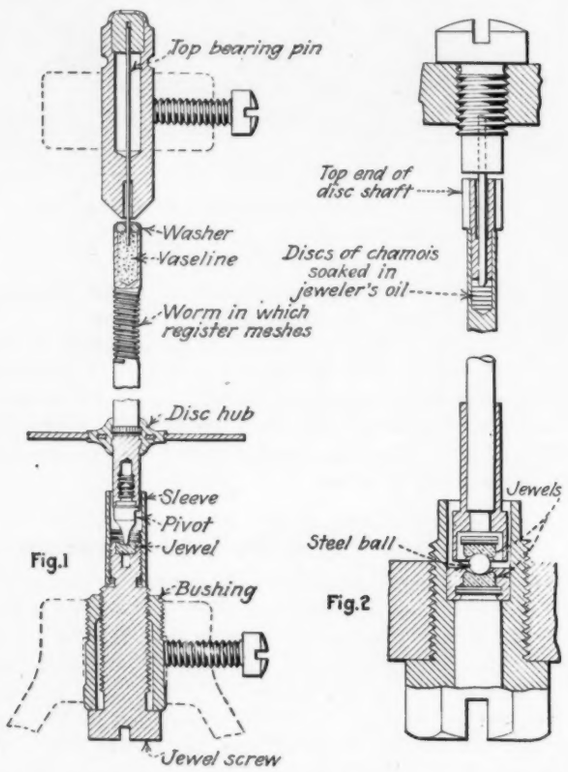
While the efficiency was naturally not good, it proved surprisingly easy to maintain fairly uniform steam pressure, and the experience has been gratifying in demonstrating that it is unnecessary to use a special small boiler for the light summer load on a central heating plant.

Some Causes of Incorrect Registration of Watt-Hour Meters

By W. F. WALSH
System Meter Supervisor, Central Hudson Gas & Electric Co., Poughkeepsie, N. Y.

AFTER a watt-hour meter has been properly connected and adjusted, there are a number of things that can develop to cause incorrect registration; the author enumerates these and tells how to determine which is causing the trouble.

A WATT-HOUR meter is one of the most accurate and dependable metering devices in use. Owing to the care and supervision used by the manufacturers and users in the meter's construction, test and maintenance, it lives up to its reputation in a remarkable manner and can generally be relied upon to fulfill its duties accurately and correctly. A meter may be found inaccurate or defective due to: Defective bearings; low top bearing; friction in register; tight or loose gear mesh; bent shaft; loose pointers; dirt on magnet jaws; loose magnets; open potential coil; short-circuit in potential coil; short-circuit in current coil; creeping. If the correctness of registration is doubted, the meter should first be tested, and if found inaccurate, the cause of the trouble should be determined.



Figs. 1 and 2—Types of watt-hour meter disk-shaft bearings

Defective bearings will cause the meter to be slow at light loads when registering correctly at heavy loads. Both the upper and lower bearings should be inspected and cleaned if dirty. In some meters the end of the disk shaft is turned down to fit loosely into a small hole in the top bearing, while in others the top bearing projects down into a hole in the disk shaft, as in Figs. 1 and 2. In the first-mentioned type of bearing oil should not be used, as it may run down on the worm and cause a gum to form which will gradually develop friction between the worm and the wheel with which it meshes. The other type of top bearing is self oiling due to an oil-saturated disk or grease reservoir being placed at the bottom of the hole. These bearings may be cleaned by using a piece of linen tape and a stick of orangewood. The upper end of the disk shaft when of the turned-down type, is rolled along the surface of the linen tape, as is also the projecting type of top bearing. The orangewood is tapered to a point and turned around slowly in the hole of the other type of disk shaft and also used in the hole for the top bearing stud.

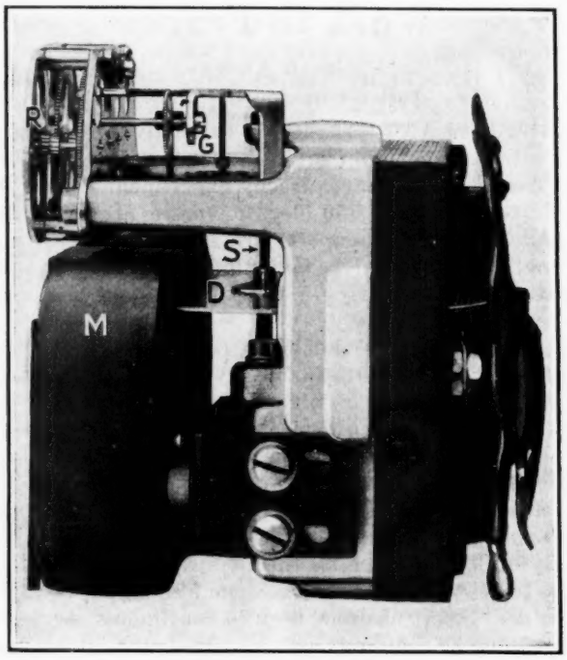


Fig. 3—Side view of single-phase metering element

At *R* is the register gear train, which is connected to the disk shaft *S* by a system of gearing at *G*. The disk *D* rotates between the poles of the magnet *M*.

The lower bearing may be tested with a finely pointed needle for a rough or a cracked surface. A microscope

or magnifying glass may be used for checking the condition of the lower bearings and also for inspecting the pivot, ball or jewel. If the jewel is found defective, the pivot or ball should be replaced as well as the jewel. The lower bearing may be oiled with a high-grade mineral oil, which can be obtained from the meter manufacturers. The lower jewel can be cleaned by turning a piece of the orangewood around its surface, and the pivot can be cleaned by pushing the point into the orangewood and turning it slowly.

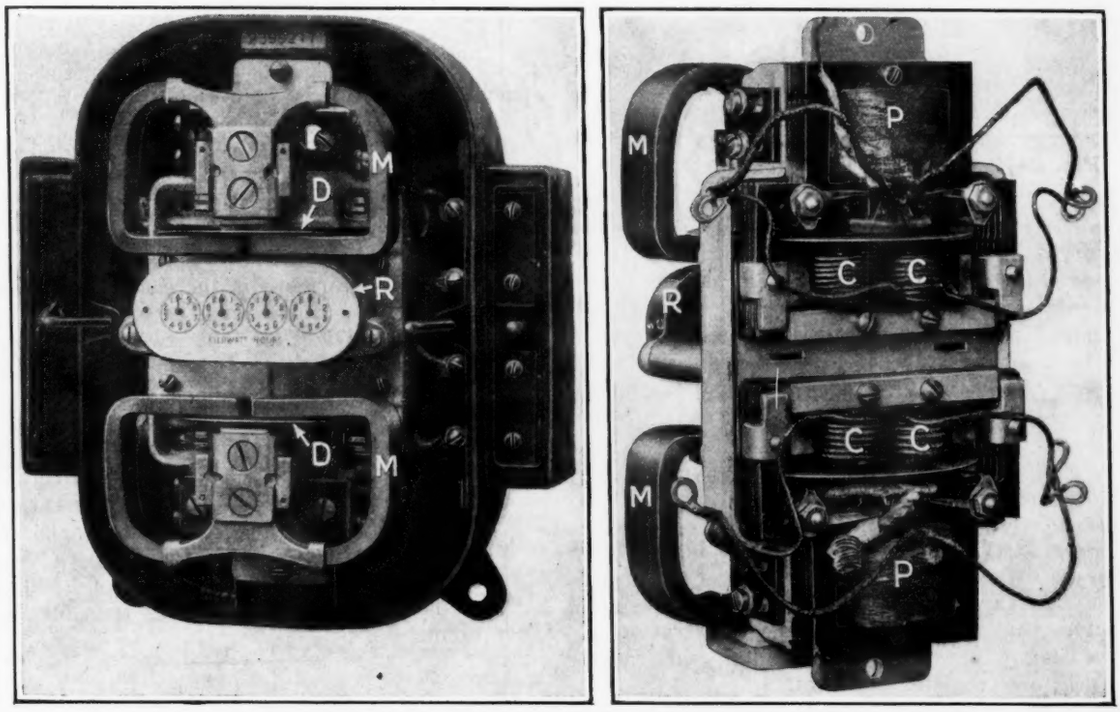
The top bearing should not be set so low that its lower surface is rubbing against the top of the disk shaft, as this condition will tend to make the meter run slow on light load. Neither should it be set so high that the shaft will slip out when the disk is moved down.

Friction in the register will result in the meter's running slow on light loads. This condition can be determined by removing the register and noting the accuracy on light loads by test. If, with constant loads, the readings are variable and inclined to be slow with the register in mesh and are constant and somewhat faster with the register removed, it is quite likely that there is friction in the register or a tight mesh of the gearing or a bent shaft. A piece of peg wood sharpened to a point and turned around in the register bearings will aid in cleaning them, and a small stiff brush may be used for cleaning the gears and pinions. Gasoline is also useful in cleaning the register.

A tight mesh of the register gearing or a bent shaft will cause friction on light loads, whereas a loose mesh will sometimes result in no movement of the dial pointers. The mesh of the worm on the disk shaft with the pinion in the register gearing should not be too deep, as a slight amount of play is necessary to prevent friction. Some gear meshes are so designed as to be adjustable by means of screws, while others are in a fixed position. If the disk shaft is bent, only a certain part of each disk revolution may register, owing to an intermittent worm and pinion mesh.

Although loose pointers do not affect the accuracy of a meter, they may cause a large error in the dial reading. If loose, they should be pulled off with a dial pointer tool and reset firmly. If more than one pointer is loose, it is advisable to remove all the pointers, reset them firmly on the zeros and then set them to as near the proper reading as can be determined.

Dirt on the magnet jaws will result in under registration and sometimes will cause the disk to stop entirely. The iron fillings or dirt on the magnet should be removed by means of a card or bronze magnet cleaner and not with a steel magnet cleaner, as the latter is likely to change the strength of the magnet jaws and so change the accuracy of the meter on all loads. A magnet cleaner is a flat tapered piece of metal that can be obtained from the meter manufacturers.



Figs. 4 and 5—Front and rear views of a polyphase induction-type watt-hour meter

By changing the position of the magnets *M* on the disks *D*, the speed of the meters is adjusted to record correctly on the register *R*. In the metering elements the potential coils are marked *P* and the current coils *C*.

Loose magnets will cause the meter to be either fast or slow on both light and full loads. When the magnet is loose owing to loose clamping screws, this can readily be taken care of by tightening up the screws. If the magnets are loose in the supporting fitting, it will be necessary in some forms to replace the magnets with new ones.

An open potential coil will result in no registration. In some types of meters it is only necessary to replace the potential coil, while in others it is advisable to change the whole element, which includes the current coil. The manufacturer should be referred to as to what is the best method to pursue.

Short-circuits in the potential coil will cause the meter to be fast on both light and full load. As in the case of the open potential coil, it should be changed.

A short-circuit in a current coil has a variable effect on the meter registration, as it may cause the disk to run slow on both full and light loads, or fast principally at light load, or even rotate backward when there is no load on the line. The coil should be replaced, and it is advisable to consult the manufacturer regarding the necessary parts to replace.

A creeping meter will sometimes be found due to over-compensation on light load provided the coils are not defective. A forward creeping meter will cause over-registration, whereas a backward creep will cause under-registration. It is customary to consider a meter

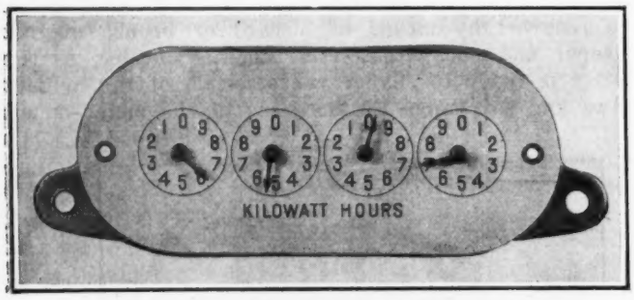


Fig. 6—Register for watt-hour meter

as creeping if it makes one revolution in less than five minutes when there is no load on the line. It is evident that a meter that is found in any of these conditions should be recalibrated after being repaired.

It is indeed rare to find the wrong register on a meter. However, sometimes registers may be interchanged on repaired meters, or in the case of meters used with instrument transformers, the transformers may be changed to a different rating and the wrong register constant be applied to the dial reading.

No matter how accurate the meter may be calibrated, if the ratio of the register is wrong, the consumption recorded is wrong. It is therefore advisable that one be familiar with the method of checking the correctness of a register on any given meter.

The factors that are involved in the registration of the kilowatt-hours are: Disk constant; gear ratio; register ratio and register constant.

The disk constant is equal to watt-hours that will be recorded on the register for one revolution of the disk. The gear ratio is the number of revolutions of the disk to cause the first dial pointer to make one revolution. The register ratio is the number of revolutions made by the gear which meshes with the worm or pinion on the disk shaft to cause the first dial pointer to make one revolution. The register constant is a number that the register reading difference for any given period of time is multiplied by to obtain the kilowatt-hours consumed during that period. The register and gear ratios may be checked by the following methods:

1. Count the number of teeth on each gear and calculate the ratio.

2. Turn the gear that meshes with the worm or pinion on the disk shaft and count the number of revolutions required to obtain one revolution of the first dial pointer.

The first method is rather difficult because the gears are not easily accessible to permit counting the teeth. The second method is preferable and therefore will be outlined.

Consider a 5-ampere 100-volt 2-wire 60-cycle GE type I-14 meter. The disk constant of this meter is 0.3, and it has no register constant. Since the meter has no register constant, the first, or right-hand, dial will record 10 kilowatts, or 10,000 watts, for one revolution of the pointer. A register of this type is shown in Fig. 5. Since one revolution of the disk represents 0.3 watt-hour and one revolution of the first dial pointer records 10,000 watt-hours, the gear ratio is $\frac{10,000}{0.3} = 33,333\frac{1}{3}$. It may be stated that all G.E. meters of modern design have a single worm on the disk shaft and 100 teeth on the wormwheel. Therefore the register ratio equals the gear ratio divided by 100, or for the meter in question, equals $33,333\frac{1}{3} \div 100 = 333\frac{1}{3}$. The register of the meter will have stamped on it the figures $333\frac{1}{3}$, and by turning the wormwheel $333\frac{1}{3}$ times this figure can be checked, for it should cause one revolution of the first dial pointer.

The modern type meters also have what might be termed a base disk constant, which increases in value in direct proportion to the increase in meter rating; that is, if a 5-ampere 100-volt 2-wire meter has a disk constant of 0.3, meters of higher ratings will have constants as in the following tabulation:

10-ampere,	110-volt,	2-wire	I-14	meter,	disk	K	=	0.6
10	"	220	"	2	"	"	"	"	= 1.2
15	"	220	"	2	"	"	"	"	= 1.8
100	"	110	"	2	"	"	"	"	= 6.0

In like manner the disk constant of a meter used with instrument transformers is increased in proportion to the product of the transformer ratios.

Consider the GE type D-6 two-element polyphase meter, which has a base disk constant of 0.6. This meter, having two elements, has a base disk constant equal to twice that of the 2-wire I-14 meter. A 10- to 5-ampere, 2,200- to 110-volt meter has a current-transformer ratio of 2:1 and a potential transformer ratio of 20:1. The product of the transformer ratios equals $2 \times 20 = 40$, and the disk constant equals $0.6 \times 40 = 24$. In like manner a 50- to 5-ampere, 33,000- to 110-volt D-6 meter has a disk constant of 1,800. A similar base disk constant set-up holds true for the other types of meters.

ACCORDING TO A REPORT RECENTLY ISSUED by the Department of the Interior, Ottawa, Canada, the known available water power in Canada from all sources is 18,255,000 hp. for conditions of ordinary minimum flow and 32,076,000 hp. under a flow estimated for maximum development, that is, dependable for at least six months of the year. It is believed that these are conservative estimates, since an analysis of the water-power plants scattered from coast to coast concerning which complete data are available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30 per cent greater than the six-months flow maximum power. Applying this, the figures quoted indicate that the present recorded water-power resources of the Dominion will permit of a turbine installation of 41,700,000 hp. The total installation to date in waterwheels and turbines throughout the Dominion is 3,569,275 hp. In other words, the present turbine installation represents only $8\frac{1}{2}$ per cent of the recorded water-power resources. Of the total maximum power available, 11,640,000 hp. is in Quebec, 6,808,000 hp. in Ontario, 5,769,000 hp. in Manitoba and 5,103,000 hp. in British Columbia.

Small Back-Pressure Turbine Saves $4,080 in Eight Months

By B. H. ROBERTS*

BY INSTALLING in a roofing mill a simple non-condensing turbo-generator at cost of $10,000 to extract power from process steam, while purchasing the balance of the power demand, $4,080 in eight months was saved over purchasing all the current used.

IN THE manufacture of asphalt prepared roofing the demand for process steam is fairly large and constant. All tanks used for asphalt storage, all asphalt pipe lines, pumps, cocks and service tanks must be steam heated. The felt base must be dried partly and heated before immersion in the saturating tanks to secure proper impregnation. Steam blankets are usually carried in the asphalt reduction stills during operation at elevated temperatures. Tank cars must be heated before their contents can be pumped into storage.

All these operations may be carried on at a steam pressure of 30 to 40 lb. In addition the mill heating system requires a considerable quantity of steam at 5 lb. pressure. This steam demand is practically constant throughout the full 24 hours, thus making an ideal load for a back-pressure turbine installation.

A survey of the Chicago plant of Bird & Son, Inc., disclosed the following operating conditions: The steam demand during seven months of the year was practically constant at 6,500 lb. per hour. During the winter months the demand rose to 8,000 lb., with a maximum of 10,000 lb. per hour. The electrical load showed a maximum demand of 200 kw., a running demand of 140 kw. for ten hours and a running demand of 75 kw. for the balance of the 24 hours.

Steam was supplied by two 72-in. by 18-ft. horizontal return-tubular boilers operating at 150 lb. pressure. All process steam was supplied through reducing valves at 30 lb. pressure.

Electrical power was purchased from an outside source at the following rates: $2 per kw. for maximum demand; 3c. per kw.-hr. for first 5,000 kw.-hr.; 1.1c. per kw.-hr. for next 25,000 kw.-hr.; 0.9c. per kw.-hr. for next 70,000 kw.-hr.; 0.65c. per kw.-hr. for next 100,000 kw.-hr.

From a careful study it was apparent that more economical operating conditions could be obtained through the use of a turbine generator exhausting into the process lines. Two plans for the employment of such a system were available:

1. The use of a simple non-condensing turbine generator exhausting at 30 lb. into process lines; purchasing from an outside source all electric power required over and above that made available by the turbine in the steam pressure reduction from 150 lb. to the 30-lb. process pressure.

2. The use of a bleeder-type turbine-generator to supply all the electrical demand, bleeding sufficient steam for process work at 30 lb.

To carry out successfully plan No. 1, it would be necessary to provide some means for balancing the electrical load with the process-steam demand. If this were not done, the turbine generator would run underloaded, with the processes drawing live steam through a bypass valve, or overloaded with the excess process steam exhausting to the atmosphere.

It was decided that the balancing of the steam and electrical loads could be accomplished by dividing the plant electrical load into six circuits having loads ranging from 10 to 75 kw. and providing means for switching each of these circuits either to the outside source or to the turbine generator as desired.

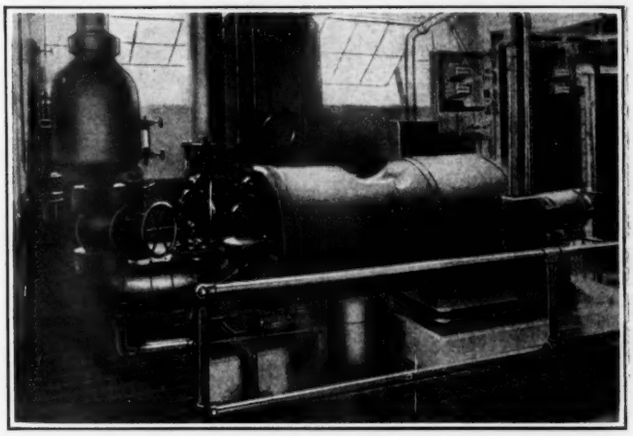


Fig. 1—Turbo-generator unit—100 kw. at 80 per cent power factor—3,600 r.p.m., 240-volt, three-phase, 60 cycles. Extracts power in process steam between 150 and 30 lb. gage

Since the outside source entered the mill at a point 400 ft. from the boiler room, it was impractical to utilize manual switching gear. Therefore, a contactor panel was designed and located at the point where the outside source entered the mill. It contains six sets of contactors, each set being operated by a push-button station located on the turbine control board in the boiler room. Through this arrangement the operator can switch any mill circuit to either the outside source of power or to the turbine generator and in this way balance the process steam demand with the electrical load.

After a careful compilation of cost and operating data, it was found that plan No. 1 necessitated an expenditure of $10,000 and promised a net saving of $4,500 a year. Plan No. 2 called for the expenditure of $19,000 and indicated a net savings of $4,600 a year. Therefore, it was decided to make the installation according to plan No. 1, providing a turbine generator

*Superintendent, Bird & Son, Inc., Chicago, Ill.

large enough to act as a stand-by source of power in case of failure of the outside source.

A 125-kva. turbine generator set was installed in September, 1925, and interconnected with the plant distribution circuits through the remote-controlled contactor panels previously described. The push-button controls were mounted on the generator control panel.

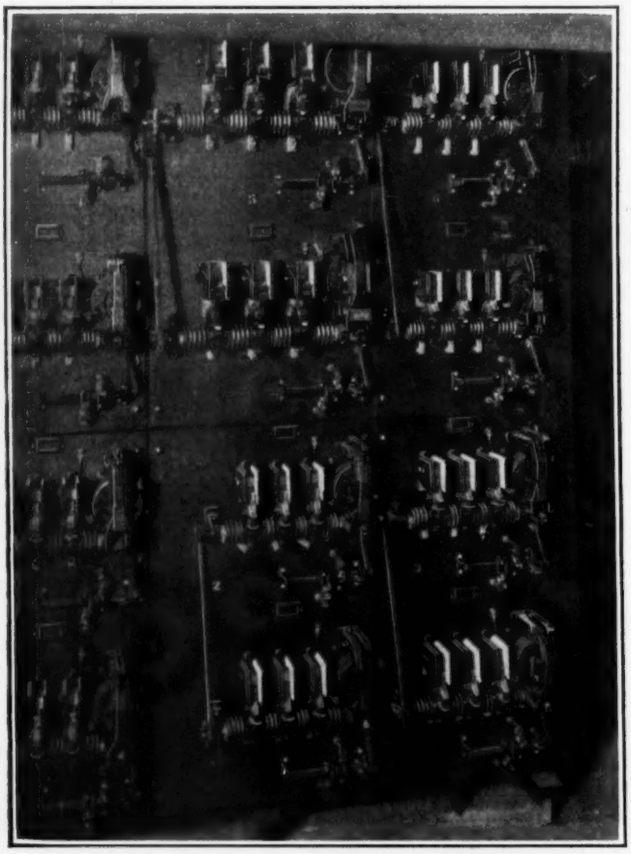


Fig. 2—Contactor panels controlled from push-button stations

To maintain constant exhaust-pressure conditions, a live steam makeup valve and an exhaust valve were installed in the process line. These valves were controlled through a regulator actuated by the pressure in the turbine exhaust main, this control being arranged to give sufficient lag between the closing of the relief valve and the opening of the makeup valve to prevent the possibility of both valves being open at the same time. The movement of the regulator was made visible to the turbine operator so that he would know when the electrical load was in balance with the steam load.

In actual operation it has been possible for the operator to keep the electrical load in almost perfect balance with the process-steam demand, thus utilizing to the fullest extent the process steam.

In the accompanying table a comparison is made of operating costs for the first eight months of 1926 with the turbine in operation and the first eight months of 1925 before installing the turbine.

During 1926 there was an increase in fuel-oil prices of $0.00279 per gallon over 1925. Correcting the fuel cost so that the comparison will be on an equitable basis adds $1,625.17 to the net saving shown in the table, making a total of $4,080.65 that can be credited to the turbine generator operation during the eight-month period and a total likely exceeding $6,000 for the year.

Manufactured power was credited to the steam plant at outside source rates. In other words, the turbine operation was credited only with the difference between actual power billing from the outside source and what it would have been had all power been purchased.

COMPARATIVE OPERATING COSTS WITH AND WITHOUT TURBINE

	First 8 Months 1926	First 8 Months 1925
Hours operated	2,880	2,860
Roofing units produced	804,662	788,968
Yearly mean temperature, deg. F.	49.3	52.9
Fuel oil burned, gal.	582,500	616,000
Total controllable expense	$31,291.76	$31,002.26
Total fixed expense	2,529.13	2,017.64
Total fixed and cont. exp.	$33,820.89	$33,019.90
Less credit for manufactured power	2,898.10	18.64
	$30,922.79	$33,001.26
Power purchased and manufactured	6,561.48	6,878.49
	$37,424.27	$39,879.75
Total net saving for 8 months	$2,455.48	

It is to be noticed that the total power manufactured and purchased shows less for 1926 than for 1925, although the roofing units produced were greater. This was due to the fact that the process operators were more careful of their power demand when operating on the limited power source. This saving was one that was not anticipated.

Overhauling Diesel Compressors

By James M. Bloomfield

A doctor, in giving a patient an examination, always tests the action of the heart, for upon this organ depends the well-being of the entire body. Similarly, when an engineer is overhauling a Diesel, he should give careful attention to its heart—the air compressor. Failure of this important apparatus destroys the functioning of the entire structure.

The first step is to remove the compressor piston, after which the compressor itself, if possible, should be removed from the bed of the engine and thoroughly scraped, and its water jacket and all water channels, holes, etc., washed. The intercooler of each stage requires dismantling and cleaning of any deposit, and the tubes should be thoroughly examined to prevent a compulsory stop when on duty. Without doubt the deterioration of the high-pressure intercooler coils is largely due to the acidity produced by the presence of lubricating oil in the high-pressure air. A spare should be kept on hand and replaced periodically, so that each coil can be cleaned of all scale on the outside and of all carbon on the inside; a simple method for the removal of the latter is to heat the coil to a dull red heat and then blow with low-pressure steam.

The coil should be weighed at specified intervals, depending upon the number of hours in use. A record should be kept in the logbook, and when the wastage by weight has reached 25 per cent of the original weight of the coil, it should be scrapped.

The valves and their connecting passages should be carefully examined to note the effect of the quality of oil supplied during running, whether too much has been used or not enough. The compressor piston should be cleaned, stripped of rings, and the wear of the high-pressure rings noted, any slackness being taken up with new rings. Throughout the cleaning of the compressor as little kerosene should be used as possible, for careless drying may result in serious trouble either in the compressor or in the air receivers.

To Remove Scale from Condenser Tubes Use Fire and Acid, Says a Tropical Engineer

A DESCRIPTION of the method followed at Mérida, Yucatan, Mexico, in removing a hard scale deposit. Tubes were removed, heated in a furnace, and then dipped in a hydrochloric acid bath. The condenser served a 750-kw. turbine.

IN THE generating station of the Compañia de Electricidad de Mérida, Mérida, Yucatan, Mexico, an unusually hard scale formed in the condenser tubes during abnormal temporary operating conditions.

The surface condenser had 2,250 sq.ft. of surface, made up of 1,070 tubes, each ¾-in. outside diameter, No. 18 B.w.g, in thickness and 10 ft. long and served a 750-kw. turbo-generator. Under usual operating conditions the little deposit from the circulating water is periodically and thoroughly removed by the usual steel-wire brushes. Normally, a vacuum of 27½ in. is easily maintained, this being a good one considering the relatively high entering temperature of the circulating water, this being 90 deg. F. The water is recirculated and is cooled in a cooling tower.

The turbine rotor, from some cause not definitely known, threw four of its blades. Owing to the absence of these blades it was necessary to run without the third stage of the machine. Under this condition the unit could develop only 600 kw., instead of the usual 750. The temperature of the exhaust steam entering the condenser was thereby increased to such an extent that the circulating water, instead of leaving the condenser at the usual 104 deg., left at 124 to 126 deg. F.

This high steam temperature in the condenser caused the rapid formation of an extremely hard scale in the tubes. Efforts to remove this scale with the steel-wire brush, which had always in the past been effective, were unsuccessful.

A new turbine rotor arrived to replace the old defective one, but it was found that at a load of 600 kw. a vacuum of only 25 in. could be obtained, whereas a 27½-in. vacuum had readily been obtained prior to the formation of the hard scale in the condenser tubes.

This uneconomical condition rendered imperative the cleaning of the coated condenser tubes or, if they could not be cleaned, their replacement with new ones. First, it was necessary to find a reasonably economical method of cleaning the tubes. Drilling was tried, an electric-driven water-flushed twist drill being used. The motor was of insufficient capacity to rotate the drill against the resistance offered by the incrustation, and a large motor was substituted. Then the drill "bit" into the scale and turned the tube. As it was impossible to secure the tube against turning without crushing, the drilling method was abandoned.

The chemical methods of removing condenser-tube incrustation, without withdrawing the tubes from the condenser, were considered. They were discarded because of the possible risk they would involve to the condenser and to the electrical machinery in the plant. A breakdown of any part of the plant would have been very serious and, considering the caliber of the labor available, a method that required the removal of the tubes was considered the more expedient.

After a number of unproductive chemical and mechanical experiments in various directions, the following successful process was devised. An incrusted tube was placed in the furnace of one of the wood-burning

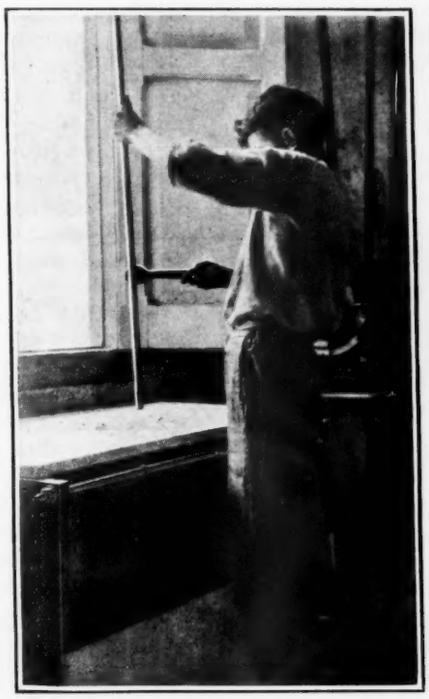


Fig. 1—Dislodging scale by hammer taps

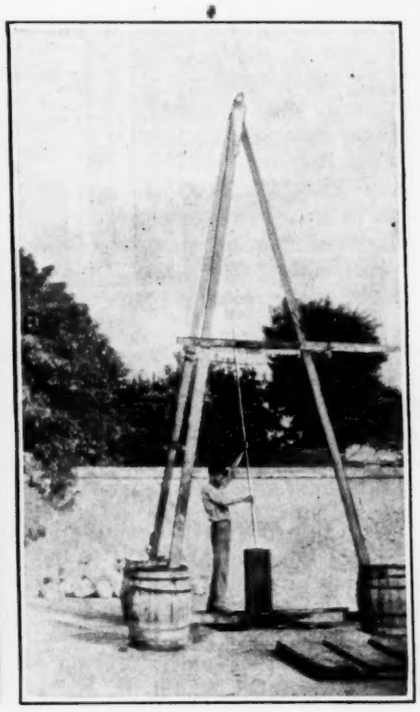


Fig. 2—Dipping tube in acid bath

boilers. It was raised to a dull-red heat, at which there could be heard crackling, indicating the calcination of the scale. After cooling, the particles of the scale could be readily discharged from the tube by holding it vertically, as shown in Fig. 1, and tapping it along its length with a wooden mallet. This removed all of the scale except a few small particles that still remained seemingly fused to the tube interior.

To clean the tube of these remaining particles, its interior was filled with concentrated hydrochloric acid. This completed the work, leaving the tube interior clean and bright. The acid really had little to do, and its use was, in a sense, a precaution rather than otherwise.

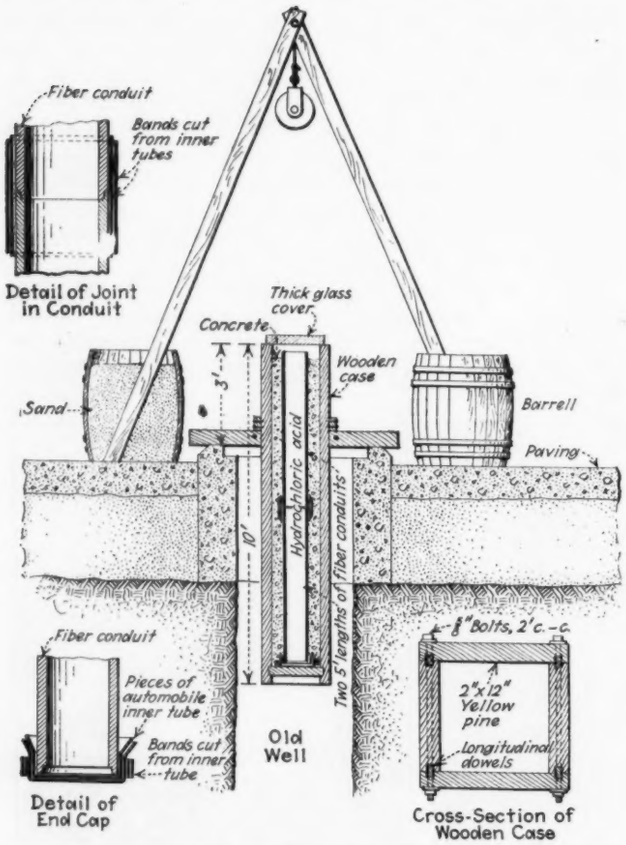


Fig. 3—Design of acid vat used in tube cleaning

With this successful cleaning method developed, there came the question, Would it be more economical to clean the tubes or to buy new ones? Each new tube cost, in Mérida, $1.70. The cost of cleaning each old tube, by the process described, was $0.75. Each old tube, uncleaned, could be sold in Mérida for $0.37½. The same number of tubes would, in any event, have to be removed from and installed in the condenser; therefore the cost of this item need not be considered. Hence the cost per tube would be:

New Tube		Cleaned Tube	
Cost of tube	$1.70	Cost of cleaning tube	$0.75
Credit value of old tube	.375		
Cost per new tube	$1.325	Cost per cleaned tube	$0.75

Difference in favor of cleaned Tube = $1,325 — $0.75 = $0.57½.

For the 1,070 tubes in the condenser the saving in favor of the cleaned tubes would be $615.25. Hence, it was decided to clean the old tubes rather than to purchase new ones. This procedure having been determined, a quantity process was developed.

During each daily off-peak shift, through which the turbine did not operate, 125 incrusted tubes were removed from the condenser. They were immediately replaced either by 125 new tubes from the storeroom stock of spares or by 125 cleaned tubes. The incrusted tubes were bound in bundles of five tubes each and calcined, as described, in the furnace of one of the boilers. The cooled tubes were then tapped with the wooden mallet to dislodge the calcined scale. Finally, the tubes, in lots of 20, were submerged, as shown in Fig. 2, in the hydrochloric-acid dip. The acid vat was developed by using tile in an old well. Fig. 3 outlines the design without the necessity of a more complete explanation. Each lot of tubes was permitted to remain in the acid for about an hour.

All the tubes were cleaned by the system and are in successful operation. The former vacuum of 27½ in. is again successfully maintained.

Power is indebted to G. H. Milke, chief engineer of the company, who developed the processes herein described, for the information given to its correspondent.

Tests on 15,000-Hp. Hamburg Diesel

Much public interest has been aroused concerning the 15,000-hp. Blohm & Voss Diesel installed in the Hamburg municipal light plant. It has nine double-acting, two-stroke-cycle cylinders of 860 mm. (33.86 in.) bore and 1,500 mm. (59.05 in.) stroke and normally runs at 94 r.p.m. The engine has an over-all length to the coupling of 23.4 m. (76 ft. 9 in.) by 4.3 m. (44 ft.) width. The height from the crankshaft center to the upper end of the valve spindles of the upper cylinder heads amounts to about 10 meters, or 35 ft. The engine is coupled to a 13,000-kva. three-phase 50-cycle 6,000-volt alternating-current generator which was furnished by the Siemens-Schuckert Works.

The installation was started early in the summer of 1926 and was subjected to acceptance tests from the 1st until Sept. 3. The following results were obtained:

The time required for starting from complete rest until taking up the full delivery of current into the line could be reduced to 3 minutes.

Upon being suddenly unloaded from full load to idling, the speed momentarily increased by 14.5 per cent, to be diminished almost immediately, and after a total lapse of 32 sec. to settle down to the equilibrium condition at no load.

The consumption of fuel, not including the electrically driven scavenging blowers, was determined according to the following table:

Load	Effective Output, B.Hp.	Indicated Output, per I.Hp.	Fuel Consumption per B.Hp.-Hr., Lb.
4–4	14,640	17,450	0.371
3–4	11,280	14,120	0.363
2–4	7,740	10,460	0.366
1–4	3,780	6,400	0.457

The excess pressure of the scavenging air assumes a value between 1,210 and 1,230 mm. water column. At the normal load of 14,640 b.hp. the power input to the scavenging blower amounts to 728 hp. According to this, the mechanical efficiency of the Diesel engine, disregarding the blower horsepower, amounts to 0.84, and with its inclusion, 0.80.

The consumption of lubricating oil for the entire Diesel engine, which was lavishly lubricated as a safety measure, amounted to only 0.0015 lb. per b.hp.-hr. at full load.

Analyzing Possible Combinations of Units in a Power Plant

By R. S. LANE*

OWING to improvements and new developments embodying better design features, the equipment of the average large power station older than ten or fifteen years is representative of the gradual evolution of our present-day approved practices. Consequently, in these older power stations which have kept pace with the trend of the times, boiler-room and engine-room installations are usually found to include some of the oldest and also some of the most modern power generating units. It is self-evident that the more varied this apparatus is, the more complicated the efficient operation of one of these stations becomes.

When the boiler- and engine-room units are of many different capacities in the same station, considerable study and concentration are required in order to get the right amount and kind of equipment for each loading condition.

It is an accepted principle that for each load factor there is a definite economical maximum rating for the boiler-room units. The higher the load factor the lower the maximum rating on the boilers should be, so that base-load stations with a factor approaching 1.00 should run their boilers at about the most efficient rating. On the other hand, in the case of traction power stations with load factors of 0.50 or under (due to pronounced peaks), the most economical method of operation requires that all boilers in service be operated at or near the maximum rating possible on the peaks. Between peaks all boilers in service should be kept equally active until all are running at or below their best point on the efficiency curve. On all ratings lower than this boilers may be banked or not, but care should be taken that none of the active units is forced above its best efficiency rating.

Similar rules pertain to the handling of the engine-room equipment, and the general rule is that the best units are put into service first. However, after these general rules have been decided upon for any power station, there still remains a lot of detailed mathematics to be undertaken to secure the best economy from the particular equipment available.

At the start of a set of computations such as just mentioned, the factors known are the station load, along with the engine-room and boiler-room equipment available, characteristic performance curves of each type of unit, and the temperature of circulating water expected which controls the vacuum that will prevail. Any other details that may vary and change either station capacity or plant efficiency must also be considered. After definite values have been assigned for such items as unit steam rates, boiler ratings, steam conditions, vacuum expected, units to be used, etc., an approximate composite weighted engine-room rate can be computed from which the total steam demand is determined. After this, by totalizing the steam from individual groups or types of boilers in sequence of desirability, the correct amount of boiler-room equipment can be determined for one set of station conditions.

Now, should any individual condition vary, the whole computation must be repeated. Since the number of possible engine-room conditions may vary from 6 to 30, or more, owing to different unit combinations and circulating-water temperatures, to say nothing of load conditions, and since at the same time the boiler room may have many possible combinations of boilers, it would require either hundreds of sets of computations on file or elaborate daily calculations in order to operate at maximum efficiency under all conditions.

COMBINED old and modern equipment in the Fifty-Ninth Street station of the Interborough Rapid Transit Company makes long calculations necessary to find the plant capacity from the available boiler-room and engine-room equipment or in determining the combinations of units required to carry a given load. A chart has been developed for these calculations, the principle of which can be used in other power plants with like problems.

In order that this calculation may be simplified, the accompanying chart was devised by the author. It covers the equipment in the Fifty-ninth Street power station of the Interborough Rapid Transit Company, of New York City, which is typical of one of the first large power stations put into operation twenty years ago. This station contains equipment ranging from plunger-type feed-water pumps to the newest type of centrifugal pumps; generator units consisting of compound duplex engines with barometric condensers to modern 35,000-kw. General Electric turbines with 50,000-sq.ft. surface condensers. In the boiler room the equipment ranges from 6,000-sq.ft. boilers with Roney stokers good for 150 per cent of rating to 37-tuyere Taylor stokered boilers of 11,400 sq.ft., good for about 400 per cent of rating. Briefly, there are 12 engine units comprising 3 types and 64 boiler units comprising 7 types. This, coupled with variations in load and circulating-water temperature, gives one a fair appreciation of the number of different conditions possible.

However, by use of the chart, the capacity of the station can be quickly determined for any combination of engine-room equipment, boiler-room equipment and circulating-water temperature. Or, to use the chart the other way round, the boiler-room equipment needed

*Assistant Mechanical Engineer, Interborough Rapid Transit Co., New York City.

for any set of station conditions can be just as easily found.

To explain how to use the chart, suppose 26 boilers from group 1, 6 boilers from group 2, and 14 boilers from group 3, together with three 35,000-kw. turbine generators and as many 15,000-kw. engines as may be required are available, it being desired to know the maximum available station capacity. At the upper left-hand corner of the chart is a curve for the boilers from group 1 in service. This group includes the 6,000-sq.ft. boilers in the plant which can be operated at 250 per cent of rating, each boiler delivering 46,600 lb. of steam per hour. The dashed line on the chart indicates the method of solution. Finding 26 on the upper left-hand scale, project to the right to the first straight line. From the point thus determined, drop vertically to the line in the family of curves directly below that represents "6," which is the number of boilers in service from group 2. The boilers in this group are 6,000-sq.ft. units which can be operated at 180 per cent of rating, each delivering 33,750 lb. of steam per hour.

From this point, project to the right to the line marked "14" in the family of curves representing the boilers in group 3. These are 6,000-sq.ft. boilers capable of being operated at 300 per cent of rating, each delivering 56,300 lb. of steam per hour. Each of the largest boilers in the plant is considered equivalent to two in this group. Then project vertically to the upper line of the highest group of curves, this line representing three turbines operating with as many 15,000-kw. engines as required, it is found that three turbines and two engines are required to carry the load. With circulating water available at 40 deg. F. or below, this point projected to the scale on the right would give the normal capacity of the station. However, assuming that the circulating water is available at 60 deg. F., the plant capacity is reduced, of course, and is found by projecting to the right only as far as the 60-deg. line in the last family of curves, dropping to the 40-deg. line and then projecting to the right-hand scale. The capacity, for the conditions assumed, is found to be 132,300 kilowatts.

The loss of capacity due to the circulating water being 60 deg. rather than 40 deg., is measured by the extent of the drop in the last family of curves. In this case this loss of capacity amounts to 139,200 — 132,300 = 6,900 kilowatts.

The reverse procedure also represents a type of calculation that is very useful. If the problem is to find how a given station capacity may be divided between the available engine-room and boiler-room equipment, the solution is made as indicated by the dashed line, except carried out in the reverse direction from the solution just outlined.

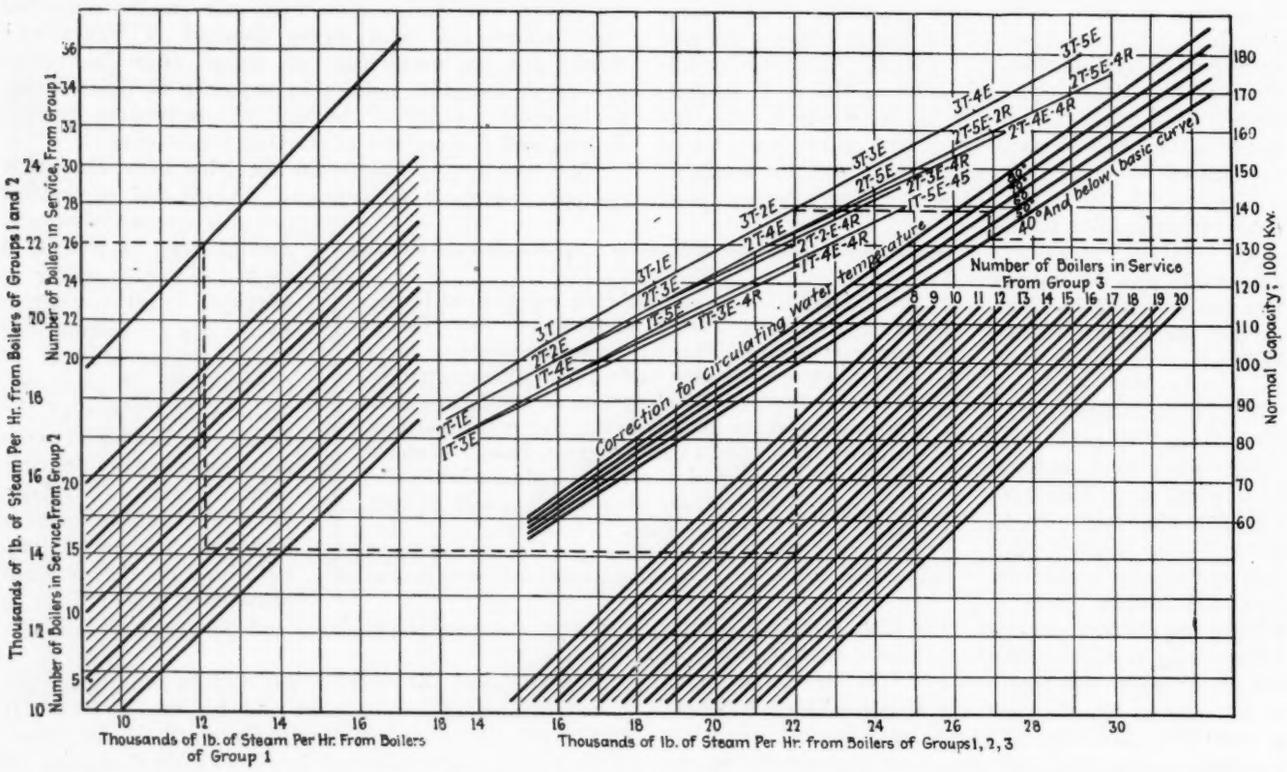


Chart for studying combinations of equipment in the Fifty-ninth Street power station of the Interborough Rapid Transit Company

This chart, of course, specifically applies to conditions at the Fifty-ninth Street station as described. However, a similar chart could be easily constructed for any other plant in which similar complications existed.

Method of Constructing Chart Suitable for Other Plants

It is first necessary to determine the maximum rating desired from each type of boiler to be used in the station and next the capacity and average steam rate, at lowest circulating-water temperature, for each type of engine-room unit to be considered.

The effect of circulating-water temperature on sta-

tion output must be determined by making a study of the variations in vacuum resulting with a change in circulating-water temperature. This information can usually be obtained from past test data and operating records. In general, with big units and good condensers the station efficiency is reduced about 2.5 per cent for each 10-deg. increase in circulating-water temperature.

Laying Out the Axes and Plotting the Curves

The first line plotted may be called the multiplication curve, since it multiplies the number of boilers of one group by the output per boiler. The largest group of boilers in the station should be taken care of through this device. By laying off two axes in terms of "total boilers in service" and "pounds of steam output," a sloping straight line may be located in the space bounded by these axes, so that when projecting from any number on the "boilers in service" axis to the sloping line and at this point turning at 90 deg. and projecting on to the "total output" axis, the figure intercepted here will represent the steam output for the "boilers in service" selected. For the case represented by the dashed line, this output is 1,210,000 lb. per hour.

Next, by means of graphical addition there must be added to this figure the output from the boilers in each of the lesser groups, successively. This is accomplished for the next group of boilers by locating another "total steam output" axis at right angles to the one just mentioned and in the area bounded by these two "output" axes locating a line for each additional boiler in service. Then when a point on the first output axis is projected to one of these lines and here turned at 90 deg. and projected to the second output axis, it will intercept a point on this second axis that will be the total output of the two groups of boilers thus far considered. For the case illustrated, this amounts to 1,413,000 lb. per hour.

Two Points Determine Each Line

In order to plot these lines, two points on each one should be determined and a straight line drawn through the two points thus located. To determine a point on one of these additional boiler lines, project a line out from the first axis at some given value and on this projection locate a point that will be equal on the second axis to the value picked on the first axis plus the output of the number of boilers the line being plotted represents.

To include more groups of boilers, another output axis is again located at right angle to the last one and the process above is repeated as many times as is necessary.

In the chart submitted for illustration purposes, the multiplication curve is in the upper left-hand corner and the first addition group directly below, with a third additional group to the right of the second. However, this is not at all a fixed rule, as these groups may follow one another in any arrangement desirable so long as the fundamentals outlined are followed carefully, the most important of which is that each additional output axis shall be at 90 deg. to the previous one.

After the output from the last group of boilers has been added, the final total steam output axis is located where the number of pounds of steam generated in the entire boiler plant is shown for any combination of boilers. In the example this total boiler-room output is seen to be 2,200,000 lb. per hour.

The next step is to change from pounds of steam to kilowatt-hours of station output. In order to do this, a "kilowatt-hour output" axis is located at 90 deg. to the "total steam" axis, and in the area between these two axes are plotted the combined Willans lines for each different engine-room combination possible. This is done by figuring the kilowatt output and steam input for a number of points for each grouping of engine units and then drawing a curve through these points to represent the combination considered.

These Willans lines should all be based on the steam rates that prevail at the lowest average circulating-water temperature, as corrections for warmer circulating water will be made separately.

Correcting for Circulating Water Temperature

To correct the kilowatt output as determined from the Willans lines, for warmer than minimum circulating-water temperature, a group of correction lines must be employed. There is first located the "no correction" line at any convenient slope near the Willans lines and in the same general direction. This is the "40 deg. and below" line in the chart. To put in a correction line for any particular temperature of circulating water, one must first determine from the data and records available what the average effect is on the station output for the temperature considered in terms of per cent. To locate the correction line itself, first pick any two separated points on the "no correction" line (the line representing minimum circulating-water temperature) and through these two arbitrary points draw lines parallel to the kilowatt output axis. On these two parallels locate two points that are a distance (in kilowatts) away from the "no correction" line equal to the correction for the circulating-water temperature considered and in a plus direction as referred to the kilowatt axis.

This process should be repeated for each temperature of circulating water to be considered.

The result will be a useful tool for determining quickly how to operate the plant and load the units. Not only will it facilitate carrying the load, but also it should promote better over-all plant efficiency.

At the End of Last Year there were 6,918 water-power plants in Switzerland, having a total capacity of 1,850,000 hp. Of these about 1,775,000 hp. was in electric generating stations, the remainder using various mechanical devices for the transmission of power. The ownership of these plants was divided as follows: Privately owned, 850,000 hp.; boroughs, 322,000 hp.; cantonal and mixed ownership, 483,000 hp.; and Swiss Federal Railway, 195,000 hp. Approximately 3,700,000,000 kw.-hr. were generated, of which 645,500,000 were exported. The utilization of water power has greatly reduced the use of coal. In 1913 fuel in a volume of 3,387,213 tons was imported; by 1925 this had decreased to 2,702,000 tons, and in 1921 it reached the low value of about one-half of the 1913 imports.

In *Engineering* (London), Oct. 22, 1926, p. 495, Telford Petrie presents Some Deductions from Steam Nozzles Research. The auther discusses test results and their interpretation.

Winter Is Coming—Look Out for Your Gages

Freezing May Render Meters and Gages Inoperative and in Some Cases Result in Serious Damage—Read How These Troubles May Be Avoided

By C. W. STEVENS

THE most vulnerable part of the plant and the one that must be watched very carefully, is the instrument equipment: Steam gages, flow meters, piping, etc. This equipment is made up with small-sized pipe that may run from the top of the boilers or overhead steam lines to the gage-board on the floor. If the building is not tight or is constructed of sheet iron with little heating, or if the steam line is outside, freezing occurs very readily. Usually, it is the lead line that freezes, as the gages are protected in some manner, but nevertheless the gage is rendered inoperative.

The protection of this equipment is quite simple and should be undertaken before cold weather sets in, to insure proper and continuous functioning.

There are numerous methods of preventing freezing, the simplest and most dependable of which are described herein.

The use of an anti-freeze mixture, such as alcohol, is probably the best method. Alcohol pervades the entire system, so that if the concentration is maintained, freezing is impossible. It is best applied by disconnecting the two ends of the pipe line, one as near the steam line or boiler as possible, and the other at the gage. The line and gage should be completely drained of water and filled with alcohol from the higher end until it flows from the lower opening, making a quick connection of the lower end. If the gage is at the lower end of the line, which is usually the case, no break in this end of the line is necessary, as gages are generally provided with a drain valve, which can be opened to drain the water, and quickly closed when alcohol appears. A funnel fitted with a quarter-inch nipple is useful for filling the line, as it can be screwed into the upper end. By keeping the funnel well filled, the line can be kept free of air, and when the alcohol appears at the lower end, the line will be completely filled.

Since alcohol is soluble in water, the water left in the coil or mechanism of the gage will be absorbed by the alcohol and become non-freezing. For this reason it is best to fill with straight grain alcohol (denatured) rather than use a made up anti-freeze solution of reduced strength.

The disadvantage of alcohol is its solubility in water and low boiling point. Condensed steam will gradually replace the alcohol, and the concentration will gradually diminish with a corresponding rise in freezing point to within the atmospheric range of temperature. The system should then be immediately refilled.

For flow meters, venturi meters, etc., that might be exposed to freezing temperatures, not only should the lines be filled with alcohol, but the meters should contain a solution of sufficient strength to prevent their freezing and bursting. No appreciable error would be introduced in their reading, as the density would become uniform, owing to the diffusion of the alcohol uniformly throughout the entire system.

Usually, two fillings will suffice for a season. Under no normal conditions has the author found it necessary to fill a system more than three times.

For gages with long lines, particularly those exposed to the severest weather conditions, a thin oil, such as kerosene, is better than alcohol. Oil does not evaporate nor is it soluble in water, so that with proper care one filling suffices for the entire season.

The line and gage must be completely filled with oil, and there must be no leaks in the system to allow the oil to seep out, as any water that is contained or enters will readily freeze. One advantage of alcohol is that it permeates the entire line.

In using oil as a preventive, a loop or single coil should be placed at the top of the line to prevent displacement of the oil by water. Water being heavier than oil, it will tend to displace the latter.

Oil cannot be used with flow meters owing to the fact that should any water be in the system, the difference in density between the oil and water may affect the accuracy of the meter.

Where a liquid of a density different from water is used, proper correction should be applied to the gage for the change of head. For short close connections this may be negligible, but for long overhead lead lines an error of several pounds may be introduced in the change in "water leg."

Where a number of gage lines are grouped together, a steam line can be run along with the group and the entire outfit covered with tar paper or covering. The steam line will keep them from freezing; it is of small diameter and is usually coiled about the meters and keeps them warm. The danger lies in an accidental closing of the steam line.

I have seen coke salamanders or jacks, or even fires—gas, coal or wood—built alongside of large flow meters to keep them from bursting in sudden cold snaps. To prevent the steam gages from freezing, the drain valves at the gages were cracked and a small amount of steam permitted to blow to keep the lines and gages warm. This introduces a double error in reading, due to the removal of the water head of the gage line and to the drop in pressure that might result in the valve's being open to atmosphere.

I have found alcohol in gages and flow meters, or kerosene in gages, to be the surest preventive of freezing. Even in the severest weather, ten degrees below zero, no difficulty has been experienced. The instruments never failed to function at all times.

One point that should be stressed is that "a stitch in time saves nine." Preventive measures should be undertaken at once rather than take chances.

Loading Different Units

DIVERSITY of plant equipment introduces special operating problems. A single-unit plant or a plant with a few identical units—boilers and engines or turbines—has operating problems enough, but the plant with units that have different characteristics has an additional problem peculiar to itself—the distribution of load among these units.

First comes the problem of carrying the load. How many units shall be started in the early morning? Usually, this is a fairly simple problem, but it may become something of a task, and the idea of setting up a chart, as described on another page of this issue, should be helpful.

Secondly, one must distribute the load among the chosen units so as to secure the best plant efficiency. Often it is assumed that this is done when the more economical units are loaded to capacity, with the less economical left to carry the tag ends of load. That this is not the solution becomes obvious when one considers the rapid decrease in efficiency of boilers, engines, turbines and pumps at low loads. There is more to the problem than appears on the surface, and the operating engineer cannot afford to overlook it.

The Holding Company—A Problem To Be Studied

THE recent writings of Professor Ripley, of Harvard, especially that in the current issue of the *Atlantic Monthly*, upon the activities of holding companies, have attracted widespread attention. This may be attributed to the fact that electric power permeates practically every industry and exerts a far-reaching influence upon the necessities and conveniences of life, as well as to the large number of small stockholders.

As the professor points out, there are certain legitimate functions that can often best be performed by the holding company. It makes for lower cost of financing, creates a diversity of risk, permits circumventing non-uniform state laws and simplifies the problem of interconnection. It is the pyramiding of such companies and consequent minority control, the speculative element that has entered the picture. and the shifting of responsibility from the local managements, that Professor Ripley views with some apprehension.

Because of the ever-increasing demand for electricity, the comparative freedom from industrial depressions, due to a large diversity of load, and the stability afforded by public-service commission regulation, electric utilities have been classed among the safest investments. This is reflected in the large customer ownership of stock, numbering nearly three-quarters of a million individuals, which has made for better public relations and proved a bulwark against local political interference.

In view of the soundness and enviable position of the industry any practice that might tend to weaken confidence on the part of the investor or the public, would be most unfortunate. Many may honestly differ with Professor Ripley on certain phases of the subject. However, his utterances are not those of the demagogue, and his standing in the field of economics commands attention both within and without the industry. If certain practices need correction, it is better that they be corrected from within than from without.

Why Insist on an Excessive Return?

THE habit of insisting that a new machine yield an excessive profit is an absurdity that has come into almost general acceptance in power engineering.

When discussing plant improvements or innovations such as the installation of new engines or comparing the installation of a new plant with the use of purchased energy, engineers often assume that any new investment must yield twenty to thirty per cent per annum before it is justified. Notwithstanding its wide acceptance the hypothesis is not based on sound economical grounds.

Business as a whole does not show a net yield as high as thirty per cent, and if it did, money would not be so available at rates as low as six per cent. There is no more justification in making a high rate on funds invested in power generating machinery than in asking a similar return upon a building, when ten per cent is considered a satisfactory gross profit, or in case of a so-called gold mortgage bond.

Presumably, the reason for expecting a machine to pay for itself within four or five years is the possibility that by the end of that period new inventions will make the machine obsolete and more or less useless to meet the competition of factories equipped with later and more efficient machinery. It is assumed that the course of events cannot be foreseen, and so the machine's cost must be wiped out within the shortest possible time as an insurance precaution.

It is barely possible that in some lines of industry advances are such that a machine is modern for only a short term. But in the power-plant field this does not hold to such an extent.

Taking the beginning of the century as the datum line, boiler efficiencies of over seventy per cent were not uncommon, and if the highest, ninety per cent, be taken as the common one at present, the growth in twenty-five years has been less than thirty per cent, or, say, one per cent per year. Apparently, at no time during this quarter century could one say that a well designed boiler plant had become obsolete within five years of its inception. Similarly, steam engines had consumption as low as fourteen pounds per horsepower-hour and even today the largest turbines seldom uses less than seven pounds, an economical gain of fifty per cent, or two per cent per year. If steam units of like pressure be compared,

the gain is much below this. Oil-engine efficiencies have remained unchanged during three years.

One is justified in concluding that protection of the investment against obsolescence does not require a return beyond a fair rate of interest plus a moderate depreciation. If engineers and business men realized the vast difference between the useful life of power-plant machines and that of certain production machinery, engineering would shake itself of the absurdity of the thirty per cent return on prime movers.

Unfortunately too little attention is paid to the question of savings obtained through modernization of the power plant, for the cost of power is usually but a small item in the total cost of the factory product, and a fifty per cent power saving may mean only a decrease of one per cent in the total factory cost. Considered on the basis of net profit, the advantage of this decrease is more evident. If a business pays a six per cent dividend and turns over its capital twice a year, the saving in power may mean an increase in dividends of over thirty per cent—a most attractive proposition to the stockholder.

Water Power Still Remains in the Running

SOME of the discussion on the relative values of water power and steam plants in the nation's power supply would lead one to believe that hydro-electric developments were facing a period of depression. For certain sections of the country it has been stated that a large increase in the price of fuel is required to make possible the development of water power on an economic basis, compared with power production in steam plants. Some of the large steam units that have been installed or are being installed in water-power districts would tend to verify this statement.

Notwithstanding all that may be said to the contrary, water power continues to be of increasing importance to the nation's power supply. Last year, of the total power generated by central stations, thirty-six per cent was produced by water power. In the first nine months of this year the power supplied from water power plants was over thirty-eight per cent. In this, consideration must be given to the fact that power consumption has increased thirteen per cent for this period. Since the enactment of the Federal Water Power Act in 1920, there have been issued licenses for the development of approximately four million horsepower. Licenses for nearly one and one-quarter million horsepower were issued during the last fiscal year of the Federal Water Power Commission, or about one-third of the total for the last five years.

This progress has come about despite the many obstacles thrown in the way of these developments by political and other agencies. While the steam-plant development is controlled largely by economic laws, hydro-electric developments are influenced by many other factors. It is not so much a question of whether water power can compete economically with the steam plant as when it will be allowed to occupy its proper place in the nation's power supply. In some sections of the country water power may have been overdeveloped. There are other sections, however, which have very large resources that can be economically utilized, but which up to the present time have served no other purpose than the subject of voluminous discussion.

A temporary low price for fuel as a determining factor in future water power development may be misleading. There are few commodities that are subject to such wide fluctuations in price as is fuel. Past experience has shown that a low price for fuel is a very uncertain quantity and should be treated as such in any economic study of a power supply.

Color Versus Stencils for Pipe Identification

ENGINEERS have reached substantial agreement on many questions, but that of marking pipes for identification does not fall in this class. The matter has been argued for years, with little progress to show for it. From time to time various standards have been proposed by individuals and by engineering organizations, but none of them has met with general acceptance. Nor is there, as far as can be seen, much hope of an early agreement in this matter. There does appear, however, to be a slight trend toward stencil marking in preference to the use of identifying colors.

At first the idea of color identification seems appealing, since color is a sort of universal language, definite but wordless. Moreover, the color can cover the whole pipe (or its insulation) so that any visible square inch will identify it. Combinations of colors can be used to indicate not only the fluid carried, but its particular use. That these and other points have merit is indicated by the fact that color identification is widely used with a fair degree of satisfaction, even though the particular systems employed are almost as varied as the plants that use them.

On the other side of the picture are numerous defects, most of which are inherent in any system of color identification. One man out of twenty is color blind. Everybody becomes more or less color blind in dim light. Again a color may seem to be one thing by daylight and another by artificial light. All these difficulties are complicated by the great variety of fluids handled: Steam (high-pressure, superheated, bled and exhaust), hot water, service water, ice water, salt water, ammonia (liquid and vapor), air, and so on almost without limit. There are not enough principal colors to handle the situation. Scientifically, there exist thousands of distinguishable hues, but the use of similar colors under plant conditions invites confusion. Colors easily distinguishable in fresh paint look like brothers when coated with dust. Finally, the average engineer has, while he may not admit it, an artistic nature which rebels at a jumble of warring colors.

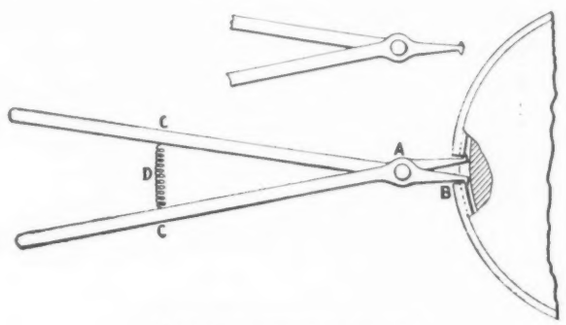
These are some of the reasons why the system of stenciling pipes, while open to the serious objection that one must stop to read, is preferred by many to color. Stencils are easily assembled or cut with simple apparatus found in any shipping room. The marking of pipes in this manner is not a very difficult task. Using standard abbreviations (such as "H.P." for high pressure) a small space is ample for indicating not only the kind of fluid contained, but where it comes from and goes to. A stenciled arrow can be used to indicate the direction of flow.

As an extension of this system the valves may be marked with serial numbers or otherwise. This is a great aid in preventing misunderstandings when giving operating instructions to subordinates, particularly new or green men. Piping diagrams showing all the valves and their numbers can be blueprinted and posted at convenient points to make things still more clear.

Practical Ideas From Practical Men

Piston Ring Remover

A contrivance for making the removal of piston rings easier is shown in the illustration. It is made of two slender pieces of steel rod *C*, hinged together at A_1 and carrying two small iron grips shown at *B*. These grips can be closed up to go under the ends of a piston ring and then to be opened again by pressing the handles together. This will open the ring, and the four pieces of



How the remover is used

tin that are generally used to remove rings can be slipped under them and the ring removed in the usual way. Of course, different sizes of this contrivance must be made for rings of widely differing diameters.

Shefford, England. W. E. WARNER.

Why is the Vacuum Low?

For some time we have had difficulty in holding the vacuum on a 2,000-kw. 1,500-r.p.m. turbine operating on 150-lb. pressure superheated steam, and it occurred to me that if the important readings over the peak-load period and a few details of the installation were given, probably some readers of *Power* could suggest the cause for the low vacuum.

We have boiled the condenser with acid, swabbed the tubes and boiled again with soda ash with little if any improvement. We have also searched for air leaks, but so far have failed to find any. Readings covering the peak-load period are given in the following table:

Time	Steam Press., Lb.	Inlet Steam, Lb.	Vacuum, In.	Load, Kw.-Hr.	Cir. Water Temp. Intake, Deg. F.	Cir. Water Temp. Discharge Deg. F.	Air Temp., Deg. F.	Condensate Temp., Deg. F.
5:00	140	95	15	750	100	126	78	190
5:30	135	90	17	700	100	123	82	178
6:00	140	70	19	750	100	120	80	170
6:30	150	90	18	750	101	120	80	168
7:00	145	90	18	800	101	121	78	174
7:30	135	100	16	800	100	123	76	180
8:00	150	80	19	700	102	120	80	180
8:30	130	105	13	900	101	121	78	160
9:00	145	80	16	750	102	120	78	175
9:30	150	80	19	700	101	120	77	170
10:00	145	90	17	800	100	118	74	176

The essential details of the installation are as follows: Length of suction and discharge line approximately 300 ft. with pump submerged. Number of spray nozzles 72 with ½-in. discharge to each nozzle. Number of 45-deg. elbows on intake line, 4; on discharge, 4. Number of 90-deg. elbows on intake, 5; on the discharge, 7. Pressure at pump, 25 lb.; at spray nozzles, 15 lb. Number of condenser tubes, approximately 1,300, size ¾ in. Cooling surface, 4,000 sq.ft. Circulating pump capacity, 3,600 gal. per min. Size of pump suction from cooling pond, 18 in.; size of main discharge to pond, 16 in.; size of connecting piece between the pump discharge and the condenser, and discharge connection between the condenser and the main line, 12 inches.

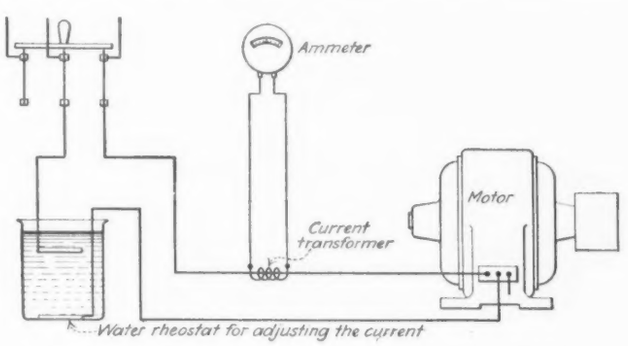
Probably some reader of *Power* has had a somewhat similar experience and could suggest the most probable cause of the low vacuum. A. W. NAPIER.

Stone, Ky.

Checking a Squirrel-Cage Rotor for Defects

Loose or high-resistance connections between the bars and end rings of squirrel-cage rotors in induction motors, was a common trouble in the earlier types of motors. Even the more modern types, which have the end rings cast on or welded to the bars, are not entirely free from these defects. Bolting or soldering the bars to the end rings used to be common practice, but these joints gave a lot of trouble, particularly if the motor was subjected to severe service.

The coefficients of expansion and contraction of the iron bolts and the copper end rings and bars are not the same, so that it is very difficult to keep them tight.



Connection for testing induction-motor rotors

In some cases it has been found that the copper rings and bars have been given a permanent deformation due to the copper expanding faster than the iron bolts, when heated. When they cool down, the copper does not come back to its original dimensions and the joint is loose. A loose joint soon oxidizes and develops a high resistance contact, which seriously interferes with the operation of the motor.

Soldered end rings will generally remain tight until the first time they are overheated; then the solder is thrown off and trouble begins. With soldered joints individual joints may be making poor contact when sol-

dered. These will heat and become loose when the machine is in normal operation.

High-resistance connections in the rotor winding will cause a reduction in torque and speed, noisy operation and heating. The latter may, if the rotor winding is in bad condition, become excessive and destroy the stator winding. Poor connections in the rotor may also be manifested by sparking between the bars and rings. In some severe cases the ends of the bars have been burned off.

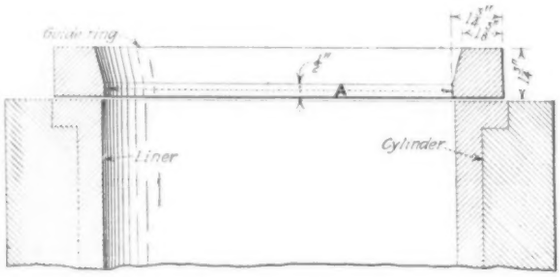
A test may be made for loose connections by connecting one phase of the stator winding to the line, with an ammeter in circuit as indicated in the figure. Means should be provided for adjusting the current to a safe value for the winding. After the current has been adjusted to give about a one-half scale reading on the ammeter, turn the rotor slowly by hand. If the rotor is in good condition, the ammeter reading will be practically constant. Loose or high-resistance connections in the rotor will be made apparent by a swinging back and forth of the ammeter's needle. The winding on the rotor acts as a short-circuited secondary of a transformer. When the connections are good between the bars and end rings, the resistance of the winding is comparatively low and a larger current will flow than when these connections have a high resistance due to poor connections. Therefore, if a section of the rotor winding with low resistance is brought into the stator's magnetic field, a larger current will be taken from the line than when a section of the rotor winding having a high resistance is in the field. In many cases poor connections are apparent in the rotor by inspection. However, the foregoing test is desirable to detect any hidden defects.

H. R. SAWYER.

Cleveland, Ohio.

A Useful Tool for Closing Piston Rings on Oil Engines

Although a special tool for closing in the piston rings when inserting the piston in the cylinder is supplied by some oil-engine manufacturers, it occurred to me



Guide ring closes piston ring gradually as piston is lowered into cylinder

that a sketch of a ring that I have made for this purpose might prove of value to some engineers.

The ring is made from forged steel and turned to the dimensions shown, with a deep chamfered surface and having a diameter *A* a few thousandths smaller than the cylinder diameter. This ring is laid on the top of the liner or cylinder, and as the piston is eased down, each piston ring in turn engages with the guide ring, the beveled surface of the latter closing the piston ring gradually and so guiding it into the liner without any trouble or delay.

The guide ring serves a double purpose, as it is used as a gage for testing new piston rings to see that the gap is sufficient to prevent butting of the ring joints and is equivalent to fitting new rings in the actual cylinder liner.

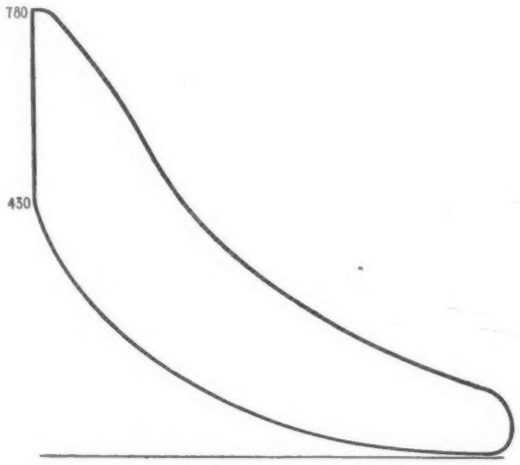
JAMES M. BLOOMFIELD.

Kamsack, Sask., Canada.

Poor Starting of Diesel Damaged Bearings

In the operation of a four-cylinder four-stroke-cycle air-injection Diesel in our plant we had a puzzling experience with fracturing babbitt bearing linings.

The top halves of the bottom-end connecting-rod bearings on Nos. 3 and 4 cylinders had the babbitt



Indicator diagram revealed excessive pressure upon starting

badly cracked, yet Nos. 1 and 2 cylinders, upon which were the air-starting valves showed no signs of cracks. The bottom-end boxes were rebabbitted and carefully rebedded to insure that no slackness would be the cause of future trouble. Some five or six months later the boxes were inspected, and again the same situation existed. When the bearings were all reassembled and the engine ready to start, I had each of the operators start the engine in turn in my presence.

Two of them were apparently very anxious that no false start should be made, so vigorously primed the fuel pump while the engine was slowly turning over with the air. The result was that at nearly every start heavy explosions occurred in Nos. 3 and 4 cylinders.

An indicator diagram of the character shown in the illustration, was obtained at the starting of the engine. This shows what careless priming combined with accumulated fuel oil would do. The normal maximum pressure was about 500 lb. per sq.in. From the indicator diagram the compression can be seen to be about 430 lb., whereas the maximum pressure registered was 780 lb. per square inch.

Of course these abnormally high pressures occurred only during the first two or three revolutions, but it shows what care must be taken by operators in priming. Careful and intelligent instructions to the operators eliminated heavy explosions on starting, and incidentally no further trouble has been experienced to date with bottom end bearings.

Yorktown, Sask., Canada. M. J. FIELD.

Comments from Readers

Bubbles in Ammonia Gage Glass

I have read with interest the discussions on what causes bubbles in ammonia-receiver gage glasses, and as a result of personally noting this action I have made a careful analysis. The action is as follows: In summer the warmth of the room causes the cooler liquid ammonia in receiver to boil slightly, and these gases rise as bubbles in the glass. In humid weather the receiver "sweats," and many more bubbles rise at such times.

In winter the same action occurs, and more bubbles rise when the machine is shut down. Frost forms on all the wetted surface of the receiver, and one can find the height of the liquid by noting the frost line. The heat in an engine room is boiling the ammonia out of the receiver, and since the heat transfer through the thin walls of the gage glass is more rapid than through the metal of the receiver, the bubbles follow one another rapidly. Air does not show up as bubbles. It simply rests in the top of the liquid as a blanket.

It is only a heat transfer from the room to the liquid ammonia that causes the bubbles. Insulating the gage glass by enclosure in another glass will prevent the formation of bubbles in the inner glass, but only by insulating the receiver carefully can bubbles be prevented from rising in the receiver itself.

By placing one's ear to any ammonia receiver when the plant is shut down, either in summer or winter, one can hear the violent boiling that is taking place inside. It is stronger in winter than in summer.

New York City. D. L. FAGNAN.

High-Pressure Steam in Heating Mains

In the Oct. 12 issue A. T. Westcott comments on a previous article on "High-Pressure Steam in Heating Mains," and says he does not approve of the practice of carrying steam to each building at full boiler pressure, then reducing in one step in the building, to 1 or 2 lb. for heating and 25 lb. for other purposes. His reasons as stated are that pressure-reducing valves are not infallible and if, for any reason, the reducing valve should fail to function, steam at full line pressure may be admitted to the heating system which is likely to damage thermostatic traps and radiators or other apparatus constructed for the lower pressure.

I am at present in charge of a boiler plant from which steam pressures are reduced from 100 lb. to 25 lb. before entering the underground tunnels. In the building the pressure is again reduced from 25 to 5 lb. to the radiator. The total surface to be heated is about 80,000 sq.ft., which does not include kitchens and other apparatus to be supplied with steam at low pressure. Our practice for the last 33 years has been to place a safety valve on the high-pressure line where the pressure is reduced from 100 to 25 lb. and in the line carrying 25 lb. close to the pressure-reducing valve, to prevent any possibility of over-pressure into the low-pressure system. A pressure recording gage is also used to adjust the reducing valve to the pressure required, and like the gage and safety valve on the boiler, it is necessary to have both for safety where pressures are automatically reduced through pressure-reducing valves, which as Mr. Westcott says, are not infallible and may be the cause of a serious accident.

Mr. Westcott suggests the use of the steam pressure gage, which should be closely observed 24 hours daily, as a substitute for a safety valve, but I see no objection to its use in connection with apparatus where steam pressure may be increased from one system to another which might cause damage or an accident.

THOMAS SUTCLIFFE, Master Mechanic,
Buffalo, N. Y. Buffalo State Hospital.

Watch the Air Leaks in the Boiler Setting

In the May 25 issue there is an article on "The Overworked Chimney," which deals with the effect of excess air on the capacity of the chimney, and which is illustrated graphically.

I was once asked to help survey a plant to see if it could be found out what was the cause of the poor draft, which was only about 0.06 in. of water. Three horizontal return-tubular boilers were in operation, and it was thought that two should be sufficient, as the evaporation amounted to only about 5,500 lb. an hour. As quick results were wanted, an induced-draft fan was recommended, but after this was installed it was found that the draft was still poor, being really no better than before. A check-up of the fan performance showed that it was doing its duty.

An Orsat and a thermometer were then obtained, and it was found that the CO_2 was about 2.5 per cent and the temperature of the flue gas that the fan was handling, was around 275 to 300 deg. The gas sample was taken from that handled by the fan because we wanted to find out why the fan had failed to give the results expected.

We then did what might have been done in the first place had we used the Orsat and the thermometer; that is, searched for leaks with a flame. We found them where we least expected, for the settings looked good, one of them being only about a year old. The leaks were nearly all at the front end of the boilers, around the breeching, and where pipes, such as the water column connections, passed through the brickwork.

As the work of stopping the leaks progressed, we could see furnace conditions improve without the evidence of the draft gage. When we had finished, the draft had increased to 0.24 in. in one furnace and 0.27 in. in another, and the last CO_2 readings taken were 9, 10 and 11 per cent. The temperature of the flue gas was increased to 450 deg., one observation being 500 deg.

The rule is that when the CO_2 is increased the flue-gas temperature is lowered, and some will say that this experience disproves the rule, but the rule applies when

the CO_2 is raised by improved furnace conditions. In this case the increased CO_2 was due to stoppage of the leaks into the smoke-box and breeching and not to improved combustion conditions, although combustion conditions were improved incidentally. Probably, if the gas sample had been taken from the usual place, in the smoke-box, in the first place, the CO_2 reading might have been fair, but the fan was what we were after.

Air leakage is undoubtedly responsible for many cases of supposed insufficient chimney capacity, and a careful study of the article referred to is well worth while.

Incidentally, this experience proves the value of proper instruments in solving problems of such nature.

Toronto, Ont., Canada. R. McLAREN.

Steam-Jet Ash Conveyors

The article by C. G. Alexander on the subject of steam-jet ash conveyors in the issue of Oct. 19 must have interested all who appreciate simplicity and convenience in handling ashes even though these cardinal advantages were accompanied by certain shortcomings in the past.

My intimate association with the development of steam-jet conveyors during the last ten years causes me to agree with Mr. Alexander on his criticism of features in early steam-jet conveyors. For instance, he is quite right in stating that standardization is wrong in view of the fact that boiler plants differ in their dimensions, available steam pressures, equipment surrounding the boilers, etc., for which reasons great care should be applied to laying out these conveyors, although by no means in every instance.

True enough, the best calculations as to efficiency, which also involves the best layout under existing conditions, have been defeated by leaks in the conveyor proper. However, this pertains to deficiencies in design of component parts to the conveyor. Excessive maintenance in the past was another justified objection. As to this, it seems that the early designers did not calculate correctly the locations of severe abrasion due to impacting action within the conveyor, and on the other hand, if they did so, these locations were difficult of access in case of inspection or replacement of liners. The best they could offer to resist this abrasion was the chilled surface of cast-iron liners. Unfortunately, once this surface wore off, these castings offered little resistance and so replacements were required comparatively often.

A vastly more effective material to resist such excessive abrasion is carborundum. Nuggets or pieces up to 1½ in. in diameter are cast closely into the surface of the hard liners, with the result that the cost of maintenance is greatly reduced.

Dust and noise were other contributing causes to the unpopularity of early installations. With the former steam consumption reduced by one-half, the basic cause of the dust and noise was reduced in proportion. In addition to this the judicious application of an effective spray nozzle has improved conditions to such a degree that steam-jet conveyors are in continuous and satisfactory operation today in hotels, hospitals, office buildings, etc.

While such a spray is effective in condensing the exhaust steam, it unfortunately contributes moisture to the ashes already somewhat moist through contact with the steam. As a consequence they become more difficult to discharge from the storage tank and are likely to freeze in cold weather. So serious was this at times, that the use of conveyors was in some cases discontinued during the winter. Manifestly, the deficiencies of the storage tank have been charged against the conveyor.

It became necessary, therefore, to design tanks that would minimize the friction of even wet ashes within them, and agitators that would effect their free flow if necessary. As a provision for freezing weather the ashes have to be thawed out with the minimum wastage of steam.

It is evident that the objectionable features of early steam-jet conveyors have been successfully eliminated. They simply had to pass through their period of development, which was reasonable to look for. Today they are the logical equipment for handling ashes.

Philadelphia, Pa. EUGENE HAHN.

The Engineer and His Education

We have been favored, during the last few months, with an illuminating discussion of the present-day status of the engineer, his education and preparation for his work and his opportunities and remuneration when engaged in his calling. It appears to me that there is a point to be seriously considered that has not been sufficiently amplified. I refer to the fitness of the man for the job, including his mental attitude toward the work in which he is a speculative apprentice. After all is said and done, is this not what really makes or unmakes a man in any profession?

We are informed that only about one-third of the technical graduates ever engage in the work for which their basic education has fitted them; also, that a much smaller proportion ever attain responsible and well-paid positions in the engineering world. The large percentage of wasted effort is pointed to as an indication of inefficiency and is charged to various sources.

Let us consider a parallel case, the group of young men who annually enter the engineering field through the "back door"—that is, as apprentices, helpers, oilers, etc., in our plants and factories. This group of young men with grammar and high-school educations must be quite as large as the group who annually enter colleges with the avowed intention of engaging in engineering study.

To attempt to give anything like accurate figures on the proportion of these youngsters who ever really develop into big men in the engineering field, would be a hopeless undertaking. It is safe to say, however, that the proportion is even less than in the case of the college-trained man. The waste connected with the training of this particular group is evidently taken for granted or not considered worthy of note. The loss is there just the same and, in my opinion, for the same reason. It is useless to argue that the reason is lack of basic education. The means of obtaining a basic education for the engineering profession are almost to be had for the asking. Surely, no man need remain in ignorance of the fundamentals of his job if he really wants to know them. Neither can it be logically argued that the lack of practical experience is the determining factor in the failure of the college-trained man. Both arguments have been disproved too many times to admit of support. The fact remains that about the same proportion of each group never get any farther than their first job takes them.

I am satisfied that the trouble does not lie in the system of education in either case; neither does it prove

that the engineering profession is one to be shunned. It does prove that a large proportion of the young men annually inducted into engineering work might be utilized to equal advantage as ribbon clerks or hod carriers.

A very superficial investigation will show that by far the majority of them when they obtain a job or a position, look upon it as a meal ticket, not as a life's work to be studied. In view of this attitude it should not be surprising if this wage is not steadily increased to really desirable proportions. For it must be evident to any but the most prejudiced that any person engaging in any calling with financial remuneration as the main object is not a producer. Industry stands for them because it must, not because it wants to.

I believe that any man who engages in any work because he really likes it will be successful in the broader sense of the word. The occasional case of the man whose ability has been exploited by his employer and sufficient remuneration denied him is an old story. Actually, the man of genuine ability transfers his field of endeavor in the line of adequate remuneration.

Milford, Conn. LISLE A. PIERSON.

All Engineers Should Be Self-Starting

Many engineers of long experience claim that the steam engineer is being pushed off the map by the central station and other causes. It is important to know just what these other causes are and what can be done to remedy them. Some engineers have been pushed out of jobs by the encroachment of the central station without even suspecting that they could possibly have prevented it. One of my best friends nearly lost out in that way.

While he was off sick for a few weeks, I took charge of his plant, and he told me at the time that the firm had been approached by a central-station engineer with a proposition to sell them power. He had been in charge of this plant for five years and had nearly made up his mind to apply for a watch engineer's job in the power company's new plant. His boiler plant was fairly modern, and his engine equipment consisted of a 500-hp. tandem-compound Corliss and a high-speed tandem-compound of the piston-valve type. For eleven hours a day both engines were required, but at night the load could be carried by the smaller engine. He had always considered that the night load could be carried by the small unit more economically than by the Corliss, as the latter would be running at only half-load, but having no measuring instruments, it was simply a guess. An indicator lay in his desk and was used occasionally.

I was not convinced that the small engine even at full load could show a lower steam rate than the large one at half-load. Indicator diagrams that I took the first night showed that the high-pressure cylinder of the small engine had a high terminal pressure, fully 15 lb. above the back pressure, which resulted in a large receiver loss. The Corliss was run the second night, and after taking cards I did some rough figuring.

The high-pressure cylinder of the Corliss was 15 in. and that of the other engine was 16 in., the speeds being 118 and 240 r.p.m. respectively. As the high-pressure cylinder of the small engine was filled with steam at 25 lb. gage, at the point of release, cylinder and stroke being 16 in., 480 strokes per minute, it was easy to get a rough idea of the amount of steam the engine exhausted each minute by multiplying the volume swept through by the piston times the weight per cubic foot of steam at the release pressure, neglecting clearance and condensation losses. The result showed 4,920 lb. an hour for the small engine at a load of 232 hp. The same method was applied to the large engine whose terminal pressure was but 10 lb. gage, and the apparent steam consumption was 3,710 lb. an hour at the same load. These figures are only relative, and inasmuch as the clearance and condensation losses would be greater in the small unit than the large one, I felt safe in assuming that the large unit was more economical for the night run.

The engine load was such a small part of the total boiler load that we could learn nothing by asking the firemen if they noticed any change in firing intervals. With no meters or coal scales and the main boiler damper burned out, the saving of a possible 1,200 lb. of steam an hour in engine steam consumption was only a drop in the bucket compared with what might be saved. The condenser was cooler and the vacuum higher with the large engine than with the small one, which gave us further assurance that this plan was practical. It would have been just as easy for the regular engineer to learn these things as for me, yet in five years he had taken no steps in that direction.

In the tentering and finishing room of this mill, hot air at 220 deg. was required, and this was heated by live steam at 40 lb. pressure. No attempt had ever been made to apply exhaust steam to this work, yet by increasing the coil surface in the air heater, exhaust steam at 15 lb. pressure could replace live steam. The ashpit doors were used for the purpose of regulating the draft on the boilers, and even then they were closed only when the safety valves blew so hard that the firemen were unable to converse without shouting. The boilers were all equipped with shaking and dumping grates, but it was practically impossible to make the firemen use them, as they claimed it was useless labor to shake the ash into the pit and pull it out again with a hoe.

When faced with the possible loss of his job, this engineer went over his plant with a magnifying glass, searching out leaks, aroused by the fact that a new man could come into his plant and correct losses whose existence he did not even suspect. I made many suggestions that he accepted in the right spirit, and in a few months the improved performance of the plant fully justified its being retained as the source of power. The engineer was going to ask for an economizer to raise the feed temperature, but when he had installed a few traps on the process steam lines and on return lines, which were emptying to the sewer, he found that his feed temperature increased to about 212 deg. thereby obviating the necessity for an economizer. The installation of suitable dampers on each boiler, as well as a main damper, produced almost unbelievable results. He told the boiler-room crew that the old order of doing things had gone forever, and while this had the desired effect on some, it was necessary to replace others on account of lack of co-operation with his plans.

This is one cause, and perhaps the greatest, of the central station pushing the engineer into the background, but fortunately it is not found so frequently as formerly. The engineers who once believed that ability to keep a plant running was enough recommendation to land a job or to hang on in a plant, are slowly being converted. It has been forcibly brought to their attention that no one is going to operate a power plant if the same service can be secured in any other way for less money and with the same or greater reliability.

Thompsonville, Conn. G. H. HART.

A new slant on things observed in and out of the power plant

What Happens and Why?

What Holds the Water in a Water Seal?

AN EFFECTIVE pressure seal often used in rotating machinery such as steam turbines or centrifugal vacuum pumps, is the water seal. The difference in pressure across this seal may amount to several pounds per square inch and yet, when in operation, the water is not blown out by this pressure differential.

To illustrate the principle involved, suppose two pressure containers are

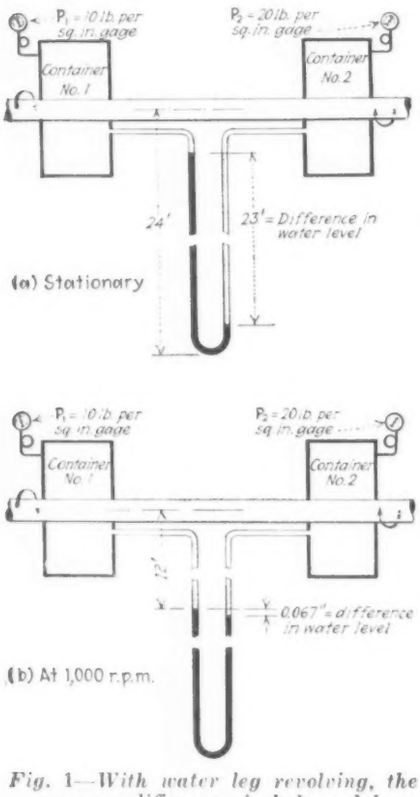

P1 = 10 lb. per sq. in. gage
P2 = 20 lb. per sq. in. gage
Container No. 1
Container No. 2
24'
23' = Difference in water level
(a) Stationary
P1 = 10 lb. per sq. in. gage
P2 = 20 lb. per sq. in. gage
Container No. 1
Container No. 2
12'
0.067" = difference in water level
(b) At 1,000 r.p.m.

Fig. 1—With water leg revolving, the pressure difference is balanced by a much shorter "head" of water

mounted on a common shaft as in Fig. 1. If, while stationary, one container is pumped up to a pressure 10 lb. per sq.in. higher than the other and a water leg is provided as a seal between these two containers, this leg will have to be about 24 ft. long. A difference in water level of 23 ft. will be required to balance the 10 lb. pressure differential.

Now suppose that these containers and this water leg could be revolved at 1,000 r.p.m. without flying apart. The excess weight of the water on one side of the leg would now be a very small factor in balancing the pressure. The increased amount of water in one leg exerts a centrifugal force due to the rotation, and this force is now the most important factor.

For example, if the area of the water leg is one square inch, a cubic inch of water located 12 ft. from the center

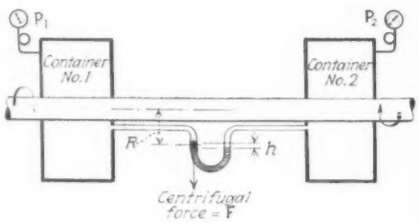


Fig. 2—Centrifugal force rather than the weight of the unbalanced water is the important factor

line of the shaft and revolving at 1,000 r.p.m., will exert a force of 148 lb. outward, found as follows:

$$\text{Centrifugal force } F = \frac{WV^2}{Rg}$$

where

W = Weight considered, in pounds.
V = Velocity, in feet per second.
g = "Acceleration of gravity" = 32.2.
R = Distance from the center of rotation to the center of weight feet.

Since a cubic foot of water weighs 62.5 lb., and there are 1,728 cu.in. in a cubic foot, the weight of the cubic inch of water under consideration is $W = \frac{62.5}{1,728} = 0.0362$ lb.

This cubic inch of water rotates on an arm 12 ft. long, so it must travel, in each revolution, $12 \times 2 \times 3.1416 = 75.5$ ft. With 1,000 r.p.m., the feet traveled per second is $\frac{1,000}{60} \times 75.5 = 1,260$. Using these quantities in the foregoing equation, the centrifugal force exerted by the cubic inch is $F = \frac{0.0362 \times 1,260 \times 1,260}{12 \times 32.2} = 148$ lb.

This force is more than 4,000 times as great as the actual weight of 1 cubic inch of water.

Thus it is evident that any force exerted by the weight is negligible when in rotation. The existing pressure difference could be balanced by a difference in level of $10 \div 148 = 0.067$ inch.

A revolving leg 24 ft. long to cover starting conditions would obviously be impracticable. Fig. 2 illustrates, diagrammatically, the usual compromise. The leg is made only long enough to take care of the difference in level when revolving, and thus it is not until the apparatus comes up to speed that the water can stay in the seal. In this figure the volume of water shown in black represents the unbalanced portion of water that counterbalances the pressure differential. Here the water levels would come to rest at a point where the centrifugal force produced by the water in h would just balance the difference in pressure.

Fig. 3 shows the application of this principle to the water seal on the exhaust end of a steam turbine. In order to keep the air from leaking into the exhaust casing and passing from there to the condenser, a labyrinth packing of some type is provided in addition to the water seal. In the case illustrated,

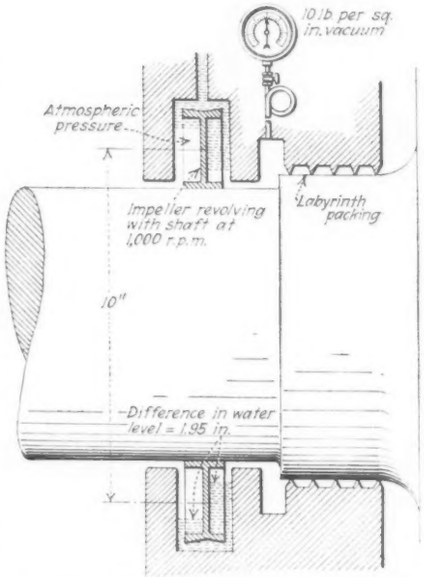

10 lb. per sq. in. vacuum
Atmospheric pressure
Impeller revolving with shaft at 1,000 r.p.m.
Labyrinth packing
10"
Difference in water level = 1.95 in.

Fig. 3—Same principle used in water seal to keep air out of exhaust hood of turbine

the drop in pressure across the water seal is 10 lb. per sq.in., as shown by the vacuum gage.

Instead of a water leg for a seal, a pump impeller running in a suitable casing is assembled on the turbine shaft. The water is introduced under pressure to the outer part of this casing. This water, revolving with the impeller, balances the pressure difference in the manner already described.

In order that some idea may be obtained regarding the magnitude of the difference in level in the water seal, suppose that the shaft is revolving 100 r.p.m. and that the mean diameter of the impeller is 10 in.

During each revolution the water travels a distance of $\frac{10}{12} \times 3.1{,}416 = 2.62$ ft. Since the speed is 1,000 r.p.m., the distance the water travels in one second amounts to $\frac{1{,}000}{60} \times 2.62 = 43.6$ feet.

The difference in the water level in the seal must be such that the centrifugal force exerted by the unbalanced water in the longer water column will amount to 10 lb. per sq.in. Since the weight of each cubic inch of water is 0.0362 lb., the weight of an unbalanced water column 1 inch square and 1 inch long will also be 0.0362. Substituting in the equation for centrifugal force,

$$F = \frac{WV^2}{Rg} = \frac{0.0362 \times 43.6^2}{\frac{5}{12} \times 32.2} = 5.13 \text{ lb.}$$

Since the actual force required per square inch is 10 lb., the corresponding difference of level must be $10 \div 5.13 = 1.95$ inch.

This same type of water seal is also often used on the high-pressure end of the turbine. Here the higher pressure is inside the turbine and the purpose of the seal is to prevent steam from leaking out into the room.

If it were not for the high speed of the shaft, this form of seal would be impractical, since the required difference in water level increases rapidly as the speed is reduced. When installed, it is in operation when the speed is much below normal. This condition occurs, of course, each time the apparatus is brought up to speed or shut down. It should be noted that the centrifugal force varies as the square of the speed. At half the speed it would be cut to a quarter.

The Iron Founder and Diesel Engine Users

AT A RECENT meeting of the Diesel Engine Users Association held in London, Horace J. Young, F.I.C., gave an interesting lecture upon the obligation of the iron founder to Diesel engine users.

It was pointed out that the future of all engines depends upon efficient design and efficient material. It is futile to test the capabilities of any design when the material is varying in quality or unsuitable for the work.

Progress in engineering has been delayed and is being brought to a standstill in England by reason of the fact that the average iron foundry is working on precisely similar lines to those used before Diesel engines were introduced. Failures were cited of engines of which the cast iron was so unsuitable, so variable, so elementary, as to overwhelm totally the importance of design.

Comparison With Steam Cylinder Problems

The investigation of problems connected with superheated steam provides a splendid training ground for those who are interested in internal combustion. In marine work, cylinder liners and piston rings, for example, often give constant and inexplicable trouble under superheat.

The speaker stated that of the many liners examined, hardly two were similar. By producing definite series of liners of definite qualities and by observing their behavior in service, he stated, it was comparatively easy to identify and to produce suitable iron. From that time superheated-steam liners produced in the foundries concerned gave no trouble in service.

Few engineers and fewer foundries consider the metal at all. As for making two castings, one one year and the other, say, twelve months later, so that one is indistinguishable, metallurgically, from the other, it is no exaggeration to say that it is seldom attempted seriously or considered necessary.

The engineer and not the foundryman is to blame for the state of the foundries. The price offered for many ordinary castings has been, and still is, such as to reduce foundry work to the level of a "sweated" industry. The specification for higher-class castings, for which a big price is paid, is unbelievably childish.

Test Bars Mislead

Test bars cast separately, test bars attached to the casting by stilts are as far as the engineer has progressed, and being useless and even misleading, they have led him nowhere. As an instance of this, a high-sulphur iron, which, in certain heavy castings, gave splendid results, if cast into a separate test bar or into a test bar attached by stilts, would produce a white or nearly white iron of no great strength. Conversely, if the test bar so cast was gray and strong, it would be proof that the large casting was everything least to be desired.

There is a fiction among foundrymen that one cannot work to both composition and physical test. So false is this that the exact opposite is the truth.

Only as far as cast iron is concerned does the engineer appear to be dominated by the foundrymen's fear of making a bad casting. This danger exists to the same extent in the case of castings of steel and all high-class alloys, but in those metals the engineer insists not only upon getting a perfect casting, but also upon the material of which it is made conforming with rigid specifications, including composition and physical properties.

Value Not Received by Purchaser

In the case of Diesel castings where the user is willing to pay a good price, the position today is that he rarely obtains value for his money. He can never hope to obtain it from any foundry that is not going as deeply into the matter of cast iron and employing as skilled assistance as does the engineer in the design of a Diesel engine.

Recently, some castings of a very high-priced iron were examined. Ten small and similar castings, some used and some unused new, were analyzed; seven were taken off engines after having been in service, and three were new ones recently made. In the most important element, namely, total carbon, there was a difference of no less than 0.48 per cent between the highest and lowest. Moreover, there was no particular percentage aimed at, apparently.

In silicon content the variation was 0.81 per cent, and in manganese 0.41 per cent. Again, no standard was to be detected and no two castings were alike.

Lack of Uniformity

Three large castings of the same expensive iron were examined, two new and one used. Here the results were even more amazing. The silicon content varied by 0.96 per cent, which variation caused one of the castings to contain more than twice as much silicon as one of the others and half as much again as the third one.

Most significant was the fact that the range of composition of the large and the small castings proved that the foundry was pouring both from whatever iron the furnace happened to be delivering when the molds were ready. This was a concrete case of the engineer paying the highest price for metal into which no knowledge of science has been put.

Practically all low-carbon cast irons on the market today are no stronger than those containing higher carbon, and until something is done to remedy the cause, low-carbon iron is hardly worth either making or using.

Purchasing of Castings Is Unwise

Not a few engine builders possessing foundries were having their important castings made outside. This indicates that the very foundries that should be gaining experience and giving thought to the problems involved, are not asked to make the important castings. It follows that while large sums are being spent upon castings, those spending them are gaining no knowledge, and no progress is being made on the metallurgical side of the question, the money expended going to outside people instead of toward the improvement of their own foundries.

That the foundry people in the face of these facts should rest content is unbelievable; that the users of engines will need better material is certain.

The fundamental requirements of modern engineering are: That iron foundries shall be capable of repeating times without limit a casting of which the material is always the same in composition and physical properties as determined by analytical and physical testing and by the microscope; that iron foundries shall be capable of producing castings to definite specifications of composition and physical properties.

At All Pressures Below About 500 Lb. throttling makes wet steam drier and adds superheat to dry steam. Expansion in a turbine or engine while it is doing useful work generally, but not always, works the other way. A very high steam rate may increase the steam quality.

Practical Refrigerating Engineers Hold Annual Convention

AT KANSAS CITY from Nov. 2 to 5 the seventeenth annual convention of the National Association of Practical Refrigerating Engineers exceeded in attendance and in the number of exhibits all past records of the organization. By the final day of the convention the total registration approximated 900 and in round numbers 60 exhibitors displayed a variety of equipment, instruments and supplies for the refrigerating plant. Headquarters was at the Muehlebach Hotel, and at Convention Hall, some two blocks distant, there were excellent facilities for the exhibits and the technical sessions.

A variety of good papers had been provided, and for the primary purpose of getting the members to talk freely, question-and-answer dialogues were conducted at odd moments. W. H. Motz and R. C. Doremus, of the national educational and examining board, introduced subjects of broad interest, such as figuring the lift of poppet valves, the use of compression pockets in ammonia compressors, simple rules for figuring compressor displacement per ton of refrigeration, relative cost and maintenance of systems for cooling condenser water, operation at different elevations, etc.

Plans for National Oil and Power Week

Plans were discussed for the observance of the national oil and gas power week in April, and in a paper that had been prepared by R. H. Switzler, president of the American Association of Ice and Refrigeration, a summary was given of the subjects under consideration for American participation in the Fifth International Congress of Refrigeration to be held in Rome during September, 1927.

Annual dues were raised from $6.50 to $7.50, the extra dollar to go into the general fund. To help defray expenses, the chapter having the convention was authorized to charge a registration fee of $3.

Entertainment was centered principally in the annual banquet held Wednesday evening, a notable affair attended by 430, and in the exhibitors' "frolic" at Convention Hall the following night. An afternoon was devoted to bus tours through the residential and industrial sections of the city and to the inspection of one of its latest and most modern ice plants.

The Opening Session

At the opening session on Tuesday Mayor Beach welcomed the visiting delegation. Erle S. Ormsby, of St. Louis, responded. President Chapman reviewed the growth of the organization and the benefits to be derived from the educational program. He appealed to plant owners to take more interest in a work that indirectly was to their advantage.

National Secretary Fox pointed out that eight new chapters had been added since the last convention, making a total of 37, all of which except one were in thriving condition. With ten chapters California was an outstanding state. Quite recently, permission had been asked to form a state association. On Oct. 1 the net membership of the entire organization totaled 2,597.

In his analysis of the finances of the association A. D. Martin, treasurer, made the pleasing announcement that about $13,500 was now available in the educational fund. Active work for the coming year is in prospect and decided efforts will be made to establish closer relations with the various chapters.

THE Seventeenth Annual Convention surpassed preceding ones in attendance, manufacturers' exhibits and in quality of technical papers presented. Eight new chapters were reported as organized during the year, and the annual dues were raised to meet the increased need of funds to carry on the educational work. Outstanding papers were "Organization Plans for an Ice Plant," by H. T. Holbrook; "Ways and Means of Increasing Over-All Plant Efficiencies," by J. R. Bernd, and "Plant Operating Records and Costs," by R. H. Smith.

Following the established plan of having equipment manufacturers discuss the research work being carried, Thomas Shipley gave an extensive talk on the new condenser design being developed by the York Manufacturing Co. This condenser in general is similar to a water-tube boiler.

F. B. Fulmer, chairman of the Board of Directors, reviewed the work of the year, enumerated the distribution of lectures and slides and announced the discontinuance of preprinting papers, owing to the lateness of their arrival and the added expense of rushing the work. Last year the proceedings were published in book form and a copy mailed to each member after the convention. It is probable that publication and distribution will be effected in the same way this year.

Mr. Holbrook's Paper

In his paper on "Organization Plans for an Ice Plant," H. T. Holbrook, chief engineer of the Union Ice Co., of San Francisco, referred to the tendency toward merging several small plants into one organization, making it necessary for the chief engineer of the holding company to supervise the operation of the various plants and organize a staff to do the work. This tendency requires that the engineer become an able executive, and to equip himself, he must study organization as well as mechanics and refrigeration from an engineering point of view. Personnel studies must be made to see that each man is fitted for his work. Systematizing of work and records are of primary importance so that the chief need spend but a minimum time on routine. A full outline was given of what the author conceived to be the chief engineer's duties, his responsibilities and the qualifications required for the work. Monthly meetings of employees were considered of great advantage in disseminating the combined knowledge of men coming in direct contact with the work.

Mr. Bernd Treats of Increasing Plant Efficiencies

"Ways and Means of Increasing Over-all Plant Efficiencies" was the subject treated by J. R. Bernd, Sr., chief engineer of the Fulton Ice Co., New York City. As the best way of making his points the author took a definite plant equipped with four freezing tanks and arranged for two suction pressures. The method of operating the tanks was to allow them to spill over and, by utilizing the spill-over liquid, increase the output without increasing the power cost per ton of ice. Details were given on the arrangement and operation of the various units, with comments on the desirability of a flexible compressor to conform to the changes of temperatures of can water and ammonia during the seasons of the year, and on methods used that had resulted in the production of a ton of ice on 40 kw.-hr.

Mr. Smith Discusses Records and Costs

R. H. Smith, of the Consumers Co., Chicago, discussed "Plant Operating Records and Costs." To turn out a block of ice for the least money, a daily record of the major items of cost under the control of the engineer, such as labor, power, water, supplies, storage, etc., coupled with unit quantities on the ton basis, was essential. At the end of the month totals would be readily available, and over a period of years there would be data for comparison. Items for the plant log were enumerated, and to keep in touch with lost motion with a view to interchanging duties, it was suggested that the labor item be split up among the different services. Results at the least cost could be had only by knowing what the plant could do and using that as the standard basis of comparison. It was essential to keep one eye on the physical equipment, the other on costs and both on the coordination of the two. Other factors having a bearing were personal appearance and cleanliness, and perhaps the most important single item of all was absolute honesty in the chief engineer,

the employer and the supplyman making recommendations on supplies and equipment.

Responsibility of the Refrigerating Engineer

Primarily, the responsibility of the refrigerating engineering profession to the public was a matter of keeping faith. According to Dempster MacMurphy, advertising manager of the Middle West Utilities Co., this could be done by establishing a code of ethics and living up to the code, as any deviation would reflect on the entire industry. It meant winning the public's interest, friendship and approval. To serve best the business he represents, the engineer must do his part in maintaining the standards set, and to produce the most efficient results he should have a knowledge of the associated items going with ice making, such as finance, sales, advertising and accounting, as well as of his chief function, the production of ice.

Mr. Shipley's Paper

A valuable contribution was a paper by Thomas Shipley, general manager of the York Manufacturing Co., giving a summary of two years of extensive research work that his company had been conducting to improve the practical operation of evaporating equipment for refrigerating plants. Tests were made first on shell and tube coolers to obtain the average heat transfer for different ammonia heads or percentages of wetted surface, while maintaining the brine velocity constant. For each head the average of several runs was taken. Data in tabulated form, including suction pressure, superheat, temperature difference, tons capacity and B.t.u. transfer, were presented to show the difference in results. Other runs were made under constant ammonia head and with the brine at different temperatures. Results improved as the head of the liquid increased.

Equipment was then designed to study the effect of varying the velocity of brine over the surface of coils and of different methods of feeding ammonia liquid into the coils. The internal velocity of the gas as it evaporated from the liquid and rushed toward the outlet and the influence of the length of the coil were investigated. Owing to the resistance to flow it was found that long coils were not so effective as short ones. Best results were obtained with short coils, high brine velocities and flooded conditions of feeding. Brine velocity was a dominating factor in the results obtained. To control this velocity the evaporating system must be encased. This eliminated vertical coils beside the cans and long coils in ice tanks.

New Coil Designs Shown on Screen

New coil designs were shown on the screen, all comparatively short and pitched similarly to the tube sections in water-tube boilers, so that it would be more easy to maintain practically all the tube surface wet and permit the gas to rise freely to the outlet. Using high brine velocities and flooded feeding of the ammonia, heat transfers as high as 175 B.t.u. per sq.ft. per minute per degree temperature difference were obtained. When these results are compared to 15 to 20 B.t.u. per sq.ft. from coil surface in the average ice tank and to 80 B.t.u. per sq.ft., which is considered good practice in the shell and tube cooler, it would seem that a transformation in the industry is imminent.

"How and Why of Compression Systems" was the subject treated by J. P. Maguire, of New Orleans. Taking each piece of equipment in the system the author analyzed it from three viewpoints—its specific duty, factors effecting economy and methods and instruments for checking results. To check the plant as a whole, he said, the better way was to develop a standard by operating the plant as efficiently as possible under the conditions existing. Then any deviation from the standard represented poor operation.

Treating Water for Ice Making

O. A. De Celle, chemical engineer of the International Filter Co., pictured the treatment of water for ice making by using colored diagrams showing in an elementary way the chemical combinations and reactions. A. J. Authenreith, vice-president of the Middle West Utilities Co., followed with an interesting address dealing with minerals found in water and their effects in the manufacture of ice, with colored slides to show what is produced in the way of ice with and without treatment.

The Snake Condenser

L. I. Denton, refrigerating engineer of the Pacific Fruit Express Co., of San Francisco, expounded on the merits of the "Snake" condenser, which is of the atmospheric type with vertical gas and liquid headers, joined by continuous, horizontal, winding pipes. In one of the company's plants a bleeder type condenser had been rebuilt into the snake type by leaving the stands of pipe, removing the end fittings and joining pipes in the same horizontal plane in adjacent stands by welding on long-turn bends. Comparative tests between the two types favored the snake condenser in that pressures 10 to 14 lb. lower were obtained under the same operating conditions. Favorable factors were the simplicity of its operation and the absence of leaks owing to the elimination of joints and valves. About 18 sq.ft. of surface per ton of refrigeration had been found most economical. The change from the bleeder to the snake type of condenser had paid 30 per cent on the investment at a cost of $60 per stand, with power at 1c. per kilowatt-hour.

Saving in power that may be accomplished by precooling the liquid ammonia before it reaches the expansion valve was a subject treated by William Jahnke, assistant superintendent of the Consumers Co., Chicago. The three known methods that may be used were described, with comments on their operation from the engineer's point of view and the effect of their operation on the rest of the plant.

Cooling Towers Discussed by Mr. Emrich

C. O. Emrich, of the F. A. Lundy Co., of Pittsburgh, talked briefly on cooling towers and in particular about a new vacuum-type forced-draft tower that would cool from 15 to 25 deg. below the outside atmosphere when the latter was 70 deg. or above, regardless of the wet-bulb temperature. By passing the air through a series of sprays into a vacuum chamber at the bottom of the tower, it was reconditioned and new dry- and wet-bulb temperatures created. The new condenser was best suited for the high temperatures and high humidities of the summer period.

As a mechanic is known by the tools he has and his arrangement of them, John W. Neff took a 100-ton plant and specified the different kinds and sizes of tools that would prove useful; the types, location and graduation of gages, thermometers and electrical instruments; and chemical testing outfits for brine, ammonia and water. Special tools, clearance gages and convenient contrivances for doing specific work were pictured on the screen.

Repair and Maintenance

"Repair and Maintenance of Electrical Equipment" was covered thoroughly by J. R. Watson, of the Ideal Electric Co. For each machine or piece of equipment that might be used in a refrigerating plant, pointers were given on what to inspect and how to do it.

Much the same plan was followed by H. J. Halterman in his paper on "Overhauling and Repairing of Ice and Refrigerating Machinery." To expedite the overhauling, he briefly outlined an arbitrary working schedule, beginning with the equipment in the boiler room and following through to the engines, compressors and the refrigerating plant. Included in the talk were suggestions for testing gages and thermometers, use of the planimeter, alignment of machines and many other details of interest.

The New Officers

The officers elected for the ensuing year are: President, B. S. T. Dobree, of New Orleans; first vice-president, Fred I. McCandlish, of Kansas City; second vice-president, F. B. Fulmer, of Oakland, Calif.; secretary, Edward H. Fox, of Chicago; treasurer, A. D. Martin, of Dallas, Tex.; sergeant-at-arms, W. C. Reinhard, of Houston, Tex. The board of directors were made up of the foregoing officers and George A. Pardee, J. S. Spalding and H. R. Halterman. The following committee chairmen were appointed: Chairman of the educational and examining board, R. C. Doremus, of Detroit; chairman of committee on standards, W. H. Lewis, of Brooklyn; on engine-room records, A. J. Authenreith, of Chicago; on exhibits, C. L. Whittemore, of St. Louis. San Francisco is to have the 1927 convention.

The Hydraulic Press—This is a semi-technical publication published by the Hydraulic Press Manufacturing Co., Columbus, Ohio. Its aim is to "disseminate constant first-hand information regarding the use of hydraulics for high-pressure operations," and the articles to be presented will show, accordingly, "typical installations of hydraulic equipment and their direct applications to the plants using them."

Recent Publications

Safety Rules for the Operation of Electrical Equipment and Lines. Handbook of the Bureau of Standards No. 8. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Paper; 4½ x 7½ in.; 63 pages. Price, 15 cents.

Previous editions of the National Electrical Safety Code have been published in complete form. There has been some demand for smaller handbooks containing a single part of the code, and in response to this demand the fourth edition is being issued not only as a whole, but also as separate publications dealing with the several subjects involved. This volume contains Part 4, dealing with rules for the operation of lines and electrical equipment, and gives specific instruction for employees when operating and working on such apparatus. This booklet is of particular interest to those who have to do with safety work in the operation of electrical equipment. Those initiating a safety system will find this handbook particularly helpful, as it gives the outline of such a system in detail.

The Cause and Prevention of Embrittlement of Boiler Plate. By Samuel W. Parr and Frederick G. Straub. Published as Bulletin No. 155 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper, 62 pages. Price 35 cents.

This booklet is the outgrowth of studies that were begun at the University of Illinois in 1912. In bulletin No. 94, published in 1917, Professor Parr discussed the embrittling action of sodium hydroxide on soft steel. The present bulletin is chiefly due to the research investigation carried on for two years in co-operation with the Utilities Research Committee representing various Midwest utilities. Preliminary studies revealed the fact that three types of cracks may occur: Corrosion cracks, fatigue cracks and embrittlement cracks. These types are described and illustrated with normal and microscopic photographs. The bulletin then proceeds to a study of various types of cracks found in practice. Finally, a laboratory reproduction of embrittlement conditions was made, in which many pieces were tested. The conclusions are too long to outline here, but are fully presented in the bulletin.

Wasserkraft Jahrbuch. Published by Richard Pflaum Druckerei, und Verlags, A. G. München, Germany, 1926. Cloth; 6½x9 in.; 168 illustrations; 7 tables; 386 pages.

This yearbook on water-power developments and their utilization consists of five parts. In Part I is included a group of fourteen articles by different authors on water-power development in various countries of the world. Part II has five articles on the use of water power, with particular reference to chemical and metallurgical industries. This section also treats of the combined use of water power and steam. The design and construction of water-power plants is the subject of Part III. An interesting section of Part IV is that dealing with the Kaplan turbines. One article is by Prof. Viktor Kaplan and another by Elov Englesson, the latter being largely responsible for the 11,000-hp. unit which was put into service recently at Lilla Edit, Sweden. In this section there is given a table of the chief dimensions of the turbines built in Europe and the United States for 29 low-head plants. Part V is an appendix giving general hydraulic information, including a comparison of the Francis, Kaplan and Pelton type turbines. A wide range of subjects has been dealt with, and the many authors add much interest to the work.

Power Plant Testing. By James A. Moyer, McGraw-Hill Book Co., Inc., New York, 1926. Cloth, 6x9 in., 609 pages; illustrated. Price, $5.

This is the third edition of a well-known text on the testing of power-plant equipment, and the work has been considerably enlarged and rewritten. Considerable space is given to the discussion of instruments used in testing, and perhaps one-third of the volume is devoted to the reprinting of such of the A.S.M.E. Power Test Codes as are now available. Some of these have not yet been officially adopted by the society and appear in their preliminary form as published in *Mechanical Engineering* and otherwise. While it is probable that these documents will not be subject to radical change, it is certain that some measure of significant alteration will be made. It is unfortunate that the document is crystallized in a bound book, which does not present the advantages of ready revision possessed by the pamphlet form of publication adopted by the society.

The volume, however, will be of value as a textbook in engineering colleges, where it should be useful in bringing before students reliable and up-to-date information on methods, and a first-hand acquaintance with the A.S.M.E. Test Codes, in their general form, with the suggestion that when they need to use such documents commercially, they seek the latest revision by the committee.

The Power Factor Book. By A. Dawes Du Bois. Published by The Electric Machinery Manufacturing Co., Minneapolis, Minn., 1926. Paper; size, 8½x11 inches; 82 pages; 56 illustrations; 15 tables.

One of the problems of paramount importance in power systems is the maintenance of good power factor. With the vast numbers of small-sized low-power-factor motors going into operation, this question takes on an ever-increasing significance. It is to assist those who have these problems to contend with that this book is published. Although it has been issued by a manufacturing company, it is in no way a trade catalog, but treats of power factor as an engineering and economic problem.

In the first chapter is given an explanation of power factor and its effects on power-system operation. Chapter II treats of the causes of low power factor. Effects of low power factor on industry are covered in Chapter III. Available remedies for low power factor are enumerated in Chapter IV, and include such subjects as prevention versus compensation, methods of improving power factor, selection and location of corrective equipment, tests and records as an aid to betterment, etc. Chapter V deals with synchronous motors as a means of improving power factor. How to solve power-factor problems graphically is shown in Chapter VI, and in Chapter VII rate practices with reference to power factor are discussed.

Guide to Swiss Hydraulic Developments. Published by the Swiss Association for the Utilization of Hydraulic Power, Zurich, Switzerland. English edition, 1926. Cloth; 5x9 in.; 538 pages; profusely illustrated; 8 tables.

To meet the demands for information on Swiss water-power developments, the Swiss Association for the Utilization of Hydraulic Power decided in 1917 to publish a guide on these developments. The object of this guide was to make reliable information in this field available, and at the same time to give a comprehensive survey of the general trend in water-power projects. The first edition was published in 1921. This is the second edition and is complete for all hydro-electric projects planned up to the end of 1925.

The main body of the book contains a brief description of 170 water-power plants in Switzerland, giving important general data of the development, the names of the manufacturers and contractors; construction costs; engineering features, showing how the developments were made; how the power is distributed; legal data; and the published literature on the project. Photographs and drawings are included, to give a comprehensive understanding of each development.

An article on the "Conditions of Hydraulic Development and the Utilization of Power in Switzerland," by A. Härry, engineering secretary of the association, is the introduction to the book. This covers the various aspects of water-power development in Switzerland. In another article the federal legislation governing the use of water power is summarized. A number of tables are included, giving data on water-power developments that have been completed or are projected. One of these tables includes 281 plants and gives such information as location and owner of the plant, water available and head, storage capacity, horsepower installed and kilowatt-hours output. This book contains a wealth of information, represents a tremendous amount of work in its preparation and is a valuable contribution to the literature of hydro-electric development.

News in the Field of Power

Gala Opening of Kearny Station Attended by Leaders of Utility Industries

Edison, Swope, Tripp, Sloan Among First Visitors—President McCarter Outlines Future Plans—A. S. M. E. Men Hold Session and Tour

INSPECTION at the formal opening of the Kearny power station of the Public Service Electric & Gas Co. of Newark, N. J., was made Nov. 9 by approximately 500 prominent men in the fields of public utilities and finance. This first day of the opening, planned as the initial of an 11-day period of inspection to be set apart for the public to view the $30,000,000 power house, included a luncheon to the visitors preceding the tour.

Outstanding figures in the electrical and power industry included Thomas A. Edison, still hale and hearty after his seventy-nine years packed with accomplishment and reminiscence; Charles Edison; Gerard Swope, president of the General Electric Co.; General Guy E. Tripp, chairman of the board of the Westinghouse Electric & Manufacturing Co.; M. S. Sloan, president of the Brooklyn Edison Co.; Samuel T. Bodine, chairman, and Aruthur W. Thompson, president of the United Gas Improvement Co.; J. H. Pardee, president J. G. White Management Corp.; W. W. Freeman, president of the Union Gas & Electric Co., Cincinnati; Charles H. Tenney; Dwight P. Robinson; W. S. Barstow; Alfred L. Loomis, Bonbright & Co., and H. H. Westinghouse, Westinghouse Air Brake Co.

"Within two years it will be necessary either to build the other half of the station or to construct another station more useful to our net needs," said President Thomas N. McCarter, welcoming the visitors at the luncheon given by the company at the Robert Treat, Newark. "Other stations may be just as good," he added, "but none is better."

Governor Moore paid a tribute to the farsightedness and accomplishments of Mr. McCarter and his associates, adding that a utility thus serving the public is entitled to "a fair break." Mr. Edison came in for many tributes, and his presence was a source of much congratulation.

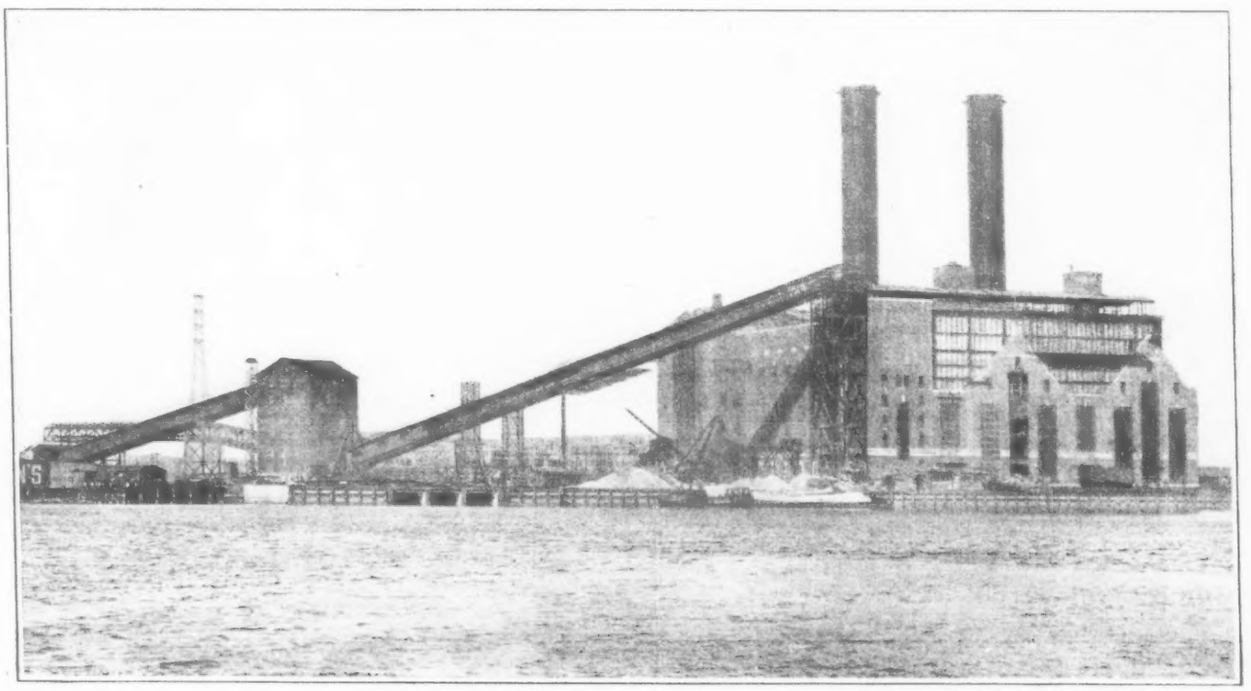
Among those guests not associated with the industry were Governor A. Harry Moore, United States Senator Edward I. Edwards, Generals Bird W. Spencer and William C. Heppenheimer; Andrew F. McBride, New Jersey Commissioner of Labor; W. G. Besler, chairman of the board of the Central Railroad of New Jersey; W. H. Truesdale, chairman of the Delaware, Lackawanna & Western, and M. W. Clement, vice-president of the Pennsylvania Railroad.

J. Pierpont Morgan & Co. was represented by Thomas S. Lamont and the Standard Oil Company of New Jersey by C. H. Haupt, chief engineer.

At the evening meeting of Nov. 11, which was attended by about 250 engineers, papers were read on "Some Features of Design, Organization and Operation of the Kearny Station," by R. J. S. Pigott, consulting mechanical engineer for the Public Service Production Co., and by J. A. Inwright, assistant chief engineer of the station, before the Metropolitan Section of the Power Division of the A.S.M.E. This topic, together with the discussion period, principally with reference to operation, which followed, was preceded by a tour through the plant in the afternoon.

Security holders were invited to visit the plant Nov. 10 and 12, Nov. 15 having been set aside for industrial power users, Nov. 16 and 17 for clubwomen and other social leaders, Nov. 18 and 19 for the general public and Nov. 13 and 20 for employees.

The Kearny plant was described in *Power*, Aug. 31, 1926, on p. 306.



Kearny Electric Power Station as seen from across the Hackensack River

G. A. Sacchi, Head of Stoker Manufacturers' Ass'n, Dies

G. A. Sacchi, president of the Stoker Manufacturers' Association and manager of the stoker sales department of the Westinghouse Electric & Manufacturing Co., died Nov. 4 at his late residence on South Lansdowne Avenue, Lansdowne, Pa.

In addition to members of the family, many of Mr. Sacchi's associates during the last thirty years, including executives of the Westinghouse organization and a large number of engineers, were present at the funeral services held from the late residence on Friday, Nov. 5. Following the obsequies the body was taken to New York City for interment in Sleepy Hollow Cemetery near Tarrytown.

Mr. Sacchi received his early school training in the State of New York. He soon identified himself with the Westinghouse Electric & Manufacturing Co., becoming associated in 1893 with the Westinghouse Church Kerr & Co., then representing the selling organization of the Westinghouse Machine Co.

Manager of Stoker Sales

When this affiliation discontinued and the Westinghouse Machine Co. had established its own sales and service departments, Mr. Sacchi had been gradually promoted and made an assistant to the district engineer at New York City serving under A. P. Boller and subsequently under M. H. Putnam, who succeeded the former. Upon Mr. Putnam's resignation Mr. Sacchi for a short time performed the duties of district engineer for the Westinghouse Machine Co.

In 1909 Mr. Sacchi became actively engaged in the sale of stokers in the New York territory, and later in the sale of large turbines. He was appointed district manager of stokers sales for New York in 1918, and subsequently manager of stoker sales for the entire company with headquarters at East Pittsburgh, Pa. With the change in the organization of the stoker department in April, 1922, when the company's administration was brought to the South Philadelphia works, Mr. Sacchi's office was transferred there.

In April, 1926, Mr. Sacchi was elected president of the Stoker Manufacturers' Association which prominent office he held at the time of his death.

Savannah R. Electric's Plan Halted by Twin Cities Power

The Federal Power Commission has just announced orally the filing with it of an application by the Savannah River Electric Co., of Greenwood, S. C., for a license for a water-power project on the Savannah River near Clarks Hill, in McCormick County, S. C., and Columbia County, Ga., below the mouth of Little River.

The proposed works will, according to the commission, consist of a concrete dam 90 ft. high and 4,200 ft. long, with a power house on the Georgia side of the river and a reservoir 32 miles long. The project is to have a power capacity estimated at 34,560 hp. and an installed capacity at 120,000 hp. The developed power is to be resold to public utilities.

The application, the commission states, conflicts with a permit already authorized to the Twin Cities Power Co. and will not be considered until that authorization is disposed of.

Sir Charles Parsons Awarded Kelvin Medal for 1926

The award of the Kelvin Medal for 1926 was made the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., distinguished member of the Institute of Civil Engineers, at a meeting of the Institution of Civil Engineers of Great Britain held Oct. 26.

The Kelvin gold medal was established in 1914 as part of a memorial to the late Lord Kelvin and is awarded triennially by a standing committee consisting of the presidents of the principal representative British engineering institutions. It is awarded for pre-

Sir Charles A. Parsons

eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified.

The first award was made in 1920 to Dr. W. C. Unwin, F.R.S., and the second in 1923 to Elihu Thomson, an American.

Eminent as an engineer and scientist and, particularly, as the perfecter of the reaction steam turbine, Sir Charles A. Parsons received the Franklin Medal in 1920.

Sir Charles Parsons was born June 13, 1854, as the fourth son of the third Earl of Rosse, who was a president of the Royal Society, and built that famous telescope which is still the largest instrument of its kind.

Builds Epicycloidal Engine

The son received his early education entirely by private tuition, and later attended Dublin University and Cambridge. At that time (about 1877) he made models of his epicycloidal engine, and while serving a four years' apprenticeship in the Elswick Works of Sir William Armstrong he constructed the first engine of this type. It was a four-cylinder revolving engine in which the cylinders rotated around the revolving crankshaft.

He then turned his attention to the development of the steam turbine. He conceived the idea of splitting up the fall in pressure over a great number of turbines in series, that the aggregate of these simple turbines, constituting a complete machine, would give an efficiency approximating that of water turbines.

In 1884 he patented his first steam turbine. This, of 10 hp., at 18,000 r.p.m., was used for driving a high-speed dynamo. It marked the beginning of turbo-generator development for electric drive. During the next five years he constructed many improved forms of turbo-dynamos. In 1889 he organized the works at Heaton.

The first compound turbine was built in 1887 and the first condensing turbine in 1892, when there was at once a great advance in efficiency, the steam consumption being reduced from 55 lb. to 27 lb. per kw.-hr. In 1895 the steam turbine was first applied to marine work, and two years later the experimental steamer "Turbinia," driven entirely by turbines, was completed. She had a length of 100 ft., 9 ft. beam, 44 tons displacement; speed attained on her trial trip, 34 knots. In 1905 the "Amethyst," driven by turbines, beat her sister ship, the "Topaz," driven by reciprocating engines.

Other Valuable Inventions

From this time on the construction of turbine-driven vessels advanced by leaps and bounds, until the present time, when the turbine has not only completely supplanted the reciprocating engine in war vessels, but to a great extent also, either wholly or partly, in the great ocean liners and mercantile steamers. By connecting the turbines to the propeller by gearing, he has made possible another great stride in turbine propulsion.

Sir Charles Parsons has made valuable contributions and inventions along other lines in physical science, among them improvements in gramophones and investigations on the formation of diamonds.

Frederic E. Bronson Elected by Ottawa & Hull Power

A. J. Nesbitt, of Nesbitt, Thomson & Co., Ltd., and president of the Ottawa & Hull Power Co., Ltd., announces that Frederic E. Bronson of the Bronson Co., Ottawa, has been elected a director of the Ottawa & Hull Power Co., Ltd., to fill the vacancy caused by the sudden death of Sir Henry Egan. The other directors of the Ottawa & Hull Power Co. are: E. R. Bremner, J. B. Fraser, J. A. Cameron, Dan. McLachlan, A. J. Nesbitt and J. B. Woodyatt.

These are also directors of the Ottawa & Hull Power Co.'s subsidiary, the Ottawa River Power Co., Ltd., as are also Right Hon. Sir Robert Borden, W. H. Dwyer and P. A. Thomson.

The Ottawa & Hull Power Co. supplies power to the City of Ottawa and to the Ottawa Light, Heat & Power Co., E. B. Eddy Co., Canada Cement Co. and the Hull Electric, and, together with its subsidiary, the Ottawa River Power has an installed capacity at present of 65,000 hp. and has under consideration increasing the Ottawa River plant by the addition of two units.

Chicago Water Conflict Up Before Supreme Court

Charges that "powerful special interests, particularly hydro-electric interests," were using the Lake States as a cloak to hide their designs and also that Wisconsin is helping Canada, were prominent features of the hearing Nov. 8, in the long war over the right of the Chicago Sanitary District and the State of Illinois to divert water from Lake Michigan. With a large corps of lawyers mobilized representing the Chicago Sanitary District and eleven different states, Charles E. Hughes, former Secretary of State, began hearings as special master of the Supreme Court of the United States, Washington, D. C.

Two cases in the Supreme Court are involved, but in both efforts are being made by Lake States to enjoin the diversion of water by Chicago. Wisconsin, Minnesota, Ohio, Pennsylvania and Michigan are united in one suit and New York has begun a separate action. Allied with Illinois are Missouri, Tennessee, Louisiana and Kentucky as co-defendants.

Arguments were heard from James M. Beck, former solicitor general, who is counsel for Chicago; Hugh S. Johnson appearing for Attorney General Carlstrom of Illinois; and Newton D. Baker, former Secretary of War, counsel for the Lake States that have joined Wisconsin. C. S. Ferris appeared for the Attorney General of New York, but did not make an argument. He will be heard later.

Mr. Baker charged that Chicago had no right to the diversion of water and that it was taking water in defiance of the federal government. He stressed the lowering of the lake levels and the injury done to harbors. He said the controversy involved 40,000,000 persons on one side against 19,000,000 on the other and that had the issue arisen in counterpart in a less civilized part of the world it would have led to war.

Mr. Beck contended the plaintiffs had no case and that they should go to Congress and the Secretary of War, not the court. He said they were attempting to have the court usurp the power of Congress. He argued that permits of the War Department to the Sanitary District had the force of law. He held the lake states were attempting to prevent Chicago from taking water even for drinking purposes.

Inland Power & Light (Ore.) Acquires Three Utilities

The Inland Power & Light Co. of Oregon, has acquired the Sherman Electric Co., the Heppner Light & Water Co., and the Condon Co., three organizations serving north central Oregon with power. The announcement was made by Guy W. Talbot, president of the Pacific Power & Light Co., an affiliated organization.

Purchase of the three companies, involving approximately $300,000 gives the Inland Power & Light Co. a network of lines with an estimated aggregate load of 2,400 hp.

The steam plants at Heppner and Condon will be rehabilitated with modern machinery and used merely as standby plants in the event of interruption on the main feeder lines, according to Mr. Talbot.

Turbine Units for Largest S. American Plant Tested

Preliminary tests are being carried out on the first two generator units installed in the new hydro-electric generating station of the Sao Paulo Tramway, Light & Power Co., Ltd., of Brazil which when completed, will be the largest station of its kind in South America.

This new station is situated at the foot of the hills which lie between the City of Sao Paulo and the port of Santos, the Serra do Cubatão as it is called locally, and draws its water from an artificial lake, or reservoir, which has been created on the tableland which extends from the serra to Sao Paulo City.

A special feature of the new plant is the high head under which the turbines operate, this being 2,450 ft. Each of the two turbines already installed is rated at 40,000 hp. and the ultimate capacity of the station will be five or six of these units, or a total of around 200,000 hp. The turbines have been supplied by the Pelton Water Wheel Co. of America and the generators by the General Electric Co., both machines being of the latest design in their respective classes.

The Cubatão station is being connected to the existing electric distribution system in Sao Paulo City and environs by a high-tension transmission line, and it is anticipated that power will be delivered over this new line within the next few weeks, thus contributing toward the further development of this rapidly growing industrial center. The American engineer A. W. K. Billings is responsible for the execution of the extensive construction work on which many thousand workmen have been engaged for some 18 months and which is now being brought to a successful conclusion.

Lehigh To Erect a $1,000,000 Engineering Laboratory

Lehigh University, Bethlehem, Pa., announced, Nov. 8, plans for the erection of a new electrical and mechanical engineering laboratory, which will be one of the finest in the country, according to the *New York Times*.

Preliminary plans have been drawn by Visscher & Burley, architects, of New York City, for the new building, which will be the largest on the campus and will cost about $1,000,000.

The laboratory will be collegiate Gothic in style, with walls of native stone, trimmed with cut limestone. It will have an over-all width of 225 ft. and a depth of 184 ft. The largest division of the building is devoted to the main laboratory, which will be occupied by both the mechanical and electrical engineering departments and will be spacious enough to accommodate the heaviest machinery.

An auditorium seating 500, a museum for the display of apparatus and data pertinent to instruction in engineering and a well-stocked engineering library are additional features.

The new building will be provided with modern and fully equipped machine shops.

Economics Course Scheduled by Milwaukee Engineers

A course of lectures on engineering economics has been arranged by the Engineers' Society of Milwaukee in cooperation with the University of Wisconsin. The lectures are to be offered by the extension division of the university, scheduled according to the following program:

November 19, Economics of Water Power Development, conducted by D. W. Mead; Nov. 26, Fundamental Principles of Railroad Rates, H. R. Trumbower; Dec. 2, Labor Management, D. D. Descohier; Dec. 9, The Place of Cost Accounting in Industry, F. H. Elwell; Dec. 17, Some of the Economic Aspects of Steam Engineering, G. L. Larson; Jan. 8, The Financing of Modern Corporations, S. W. Gilman; Jan. 15, Use of Statistics in Manufacturing, H. Jerome; Jan. 22, Economics of Gaseous Fuel, O. L. Kowalke; Jan. 29, Control and Regulation of Public Utilities, M. G. Glaeser; Feb. 2, The Engineer's Interest in Advertising, E. H. Gardner; Feb. 10, The Economics of Natural Resources, C. K. Leith.

These lectures will be given in Milwaukee at the lecture room of the Milwaukee Public Library. The charge for the entire course will be $10.

Sees Volume of Electrical Machinery as Promising

The outlook in the electrical apparatus and machinery industry according to the National Industrial Conference Board's analysis is "very good," and promises a continuation of a satisfactory volume of business "for some time to come."

The constant development of new industrial devices in all fields is continuing to bring in a steadily increasing amount of orders. The volume of industrial electrical apparatus and the market for large apparatus, while showing a seasonal slackening reflecting the lighter buying by the utilities during the fall season of the year, is anticipated to be even better during the coming year than it has been during the past year.

Plans Joint Power and Water Project—Aberdeen, Wash.

Officials of Aberdeen, Wash., are seeking a federal permit to construct a joint power and water project on the Wynooche River canyon. The city has voted $2,500,000 for the construction of the plant and preliminary work has already been started, but no permit has yet been received from the federal power commission although it is not anticipated that there will be any trouble in this grant.

The permit for the water system has been granted.

Electric Lights Once Circus' Leading Attraction

Before electric lights came into everyday use, they were circus curiosities, taking rank above any side-show freak, according to Gil Robinson, world's oldest living circus man.

"When electric lights first came along," Robinson said in a recent interview, "we carried them on the show not only to light the tents but as a curiosity." John Robinson's circus was the first show to do this, and for a couple of seasons the lights were the biggest kind of novelty.

September Electrical Output Largest on Record

The Division of Power Resources of the United States Geological Survey has just announced that the electricity generated by public-utility power plants in the United States, in September, was the largest ever produced in any one month. The average daily output during the month was 205,600,000 kw.-hr., or nearly 4 per cent greater than that for August and almost 3 per cent greater than the average daily output in February, the next highest average daily rate.

The total production of electric power in September is placed at 6,166,591,000 kw.-hr.

Buys Acreage for Power Site In South Carolina

Purchase by the Appalachian Development Co. of 540 acres in South Carolina, near the junction of the Tugalo and Seneca Rivers, as an additional step in plans for a large power site in that region, was reported Oct. 22. The Appalachian Co. is the holding company for properties of the Southern Light & Power Co. with which the Georgia Railway & Power Co. recently merged.

Personal Mention

Lester E. F. Wahrenburg has taken a position of assistant design engineer with the Duquesne Light Co., of Pittsburgh, Pa.

John A. Needy, formerly of Purdue University, has resigned his post there to become dean of engineering at Ohio Northern University, Ada, Ohio.

Norman C. Chambers is now located in Moscow, Russia, representing the Chicago Pneumatic Tool Co. He has been connected in the past with Niles Bement Pond Co. of New York, N. Y.

John A. King changed his position as instructor of mechanical engineering, at the University of Texas, Austin, to that of assistant professor of the same subject at Lehigh University, Bethlehem, Pa.

D. W. R. Morgan, engineer with the condenser department of the Westinghouse Electric & Manufacturing Co., has been appointed manager of condensing and combustion engineering.

Elwood M. Manter resigned his position as instructor of mechanical engineering at Lafayette College and has now the superintendency of the Williamson Free School of Mechanical Trades in Delaware County, Pa.

Harry H. R. Spofford, mechanical engineer, was recently elected secretary for the Copper & Brass Research Association, 25 Broadway, New York City.

W. B. Flanders, formerly engineer for the turbine division of the engineering department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has assumed the position of assistant manager of engineering.

H. L. Lilla has left the Marine shops, Harlem River, N. Y., having installed production methods, and is now at the Cos Cob Power Plant, Conn., working on production economy.

Leonard L. Youell, formerly assistant engineer of the Hydro-Electric Power Commission of Ontario, is now with the development division of the Atmospheric Nitrogen Corp., Syracuse, N. Y.

Coming Conventions

American Association for the Advancement of Science. Annual meeting at Philadelphia, Dec. 27-Jan. 1; Burton Livingston, Secretary, Smithsonian Institution Bldg., Washington, D. C.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9. Dr. Calvin W. Rice, secretary.

American Society Refrigerating Engineers. Annual meeting will be held at Hotel Astor, New York City, Dec. 6-8. Wm. H. Ross, secretary.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman, Morgan Bldg., Buffalo, First International Welding Exposition will be held in conjunction with meeting.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Annual meeting Jan. 18. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

E. LeRoy Harrington, clamshell bucket engineer and designer, is now a member of the Blaw-Knox organization. His broad experience in designing buckets for coal handling and like installations will be used in developing Blaw-Knox clamshell buckets for special services.

Alonzo G. Kinyon, manager of the conveying department of the Fuller-Lehigh Co., was awarded the Longstreth Medal by the Franklin Institute of Philadelphia, Oct. 20. The award was made on the basis of invention and subsequent development of the Fuller-Kinyon conveying system used to transport pulverized materials through pipe lines. Sole rights for the sale and installation of this system for conveying pulverized fuel are held by the Fuller-Lehigh Co., a Babcock & Wilcox organization.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Nov. 8 1926
Pool 1	New York	$4.50@$4.75
Smokeless	Boston	6.68
Clearfield	Boston	3.60@ 4.25
Somerset	Boston	3.75@ 4.25
Kanawha	Columbus	3.75@ 4.25
Hocking	Columbus	3.00@ 3.25
Pittsburgh	Pittsburgh	3.25@ 3.75
Pittsburgh gas slack	Pittsburgh	2.90@ 3.10
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky	Louisville	1.75@ 2.25
S. E. Ky.	Louisville	4.00@ 4.50
Big Seam	Birmingham	2.00@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.50
Buckwheat No. 1.	Philadelphia	2.40@ 3.00
Birdseye	New York	1.35@ 2.00

FUEL OIL

New York—Nov. 11, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Nov. 2, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10@$2.15 per bbl.; 26@28 deg., $2.15@$2.20 per bbl.; 28@30 deg., $2.20@$2.25 per bbl.; 30@32 deg., $2.25@$2.30 per bbl.; 32@36 deg., gas oil, 6.2c. per gal.; 38@40 deg., 7.8c. per gal.

Pittsburgh—Nov. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Nov. 4, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Nov. 8, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Nov. 6, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35 per bbl.; 26@ 30 deg., $1.45; 30@32 deg., $1.65.

Boston—Nov. 8, tank-car lots f.o.b. 12@14 deg. Baumé, 4.9c. per gal.; 28@ 32 deg., 6c. per gal.

Dallas—Nov. 9, f.o.b. local refinery, 26@30 deg., $1.70 per bbl.

Personal Mention

C. M. Waite, electrical engineer, has acepted a position with the Trumbull Electric Manufacturing Co., at Cincinnati, Ohio.

William T. Sherman, formerly assistant chief engineer for Stone & Webster, Inc., reports that he is now connected with the Vacuum Oil Co., at Paulsboro, N. J.

Charles R. Dickinson, designing engineer, who recently severed his association with the Alabama Power Co. at Birmingham, Ala., has engaged his services to the Federal Power Co., Anniston, Ala.

John H. Smith, condenser engineer, has recently rejoined the Elliott Co., Jeannette, Pa. Mr. Smith was with the Elliott Co. in 1912 before that company entered the condenser business. Recently he had been connected with many major condenser operations.

F. P. Fairchild has been appointed engineering manager by the Ladd Water Tube Boiler Co. Mr. Fairchild was formerly connected with the Dwight P. Robinson Co. as a power engineer in charge of design on various large steam-power developments. A member of the A.S.M.E., he is a graduate of the Engineering Department of the University of Kansas.

Society Affairs

The Franklin Institute, at Philadelphia, announces a lecture of much interest in the power field to be delivered at the lecture hall, 15 South Seventh St., Wednesday, Dec. 15, when Nevin E. Funk, operating engineer for the Philadelphia Electric Co., will speak on "Unusual Engineering Features of the Conowingo Dam and Power Plant."

Business Notes

The Liberty Manufacturing Co's general offices, formerly located in the Frick Bldg., Pittsburgh, have been moved to the Elliott Co. general office building at Jeannette, Pa. J. P. Rodgers continues as sales manager for the Liberty business.

The Allen-Sherman-Hoff Co., of Philadelphia, Pa., manufacturer of ash-handling equipment, announces that John T. Deutsch, formerly of the Baker-Dunbar Co., has been elected vice-president of the Allen-Sherman-Hoff Co. in general charge of sales.

Trade Catalogs

Fan-Cooled CD Motors—The General Electric Co. Bulletin sheet on Type CD totally inclosed fan-cooled motors, equipped with ball bearings, for 2- to 21½-hp., 230 volts or 550 volts, continuous duty—55 deg. C., shunt and compound wound.

Diesel Engines—The De La Vergne Machine Co., 949 East 138th St., New York City, is issuing bulletins on the De La Vergne vertical solid-injection Diesel engines. Among its features is pointed out the use of the simple "Type S1" pump injection system, to eliminate the complicated high pressure air compressor," which system, in place of the air injection spray valve, substitutes two simple nozzles having no external moving parts or valve gear. The nozzles are on the side of the cylinder head, thus reducing the number of openings through the top of the head.

Generator Voltage Regulators—The American Brown Boveri Electric Corp. has put out a descriptive circular No. 702 on quick-acting automatic generator voltage regulators manufactured by the company. Claims made for this product include quick response to changes of voltage, individual generator regulation, adjustability to any voltage conditions, that it can be changed over from automatic to hand regulation without opening field circuit, that the generator can be started up, synchronized and loaded under automatic voltage regulation, and that it is available in two sizes, the size to be chosen dependent on the size of the exciter.

New Plant Construction

Ark., Hot Springs—Sisters of Mercy Hospital, G. A. Callahan, Chn., will soon award contract for the construction of a 5 story hospital. Estimated cost $750,000. H. P. Hess, 1237 North Taylor St., St. Louis, Mo., is architect.

Calif., Beverly Hills—Beverly Hills Hospital & Sanitarium, is having plans prepared for the construction of a 3 and 5 story hospital including refrigeration system, elevators, etc. Estimated cost $450,000. Gable & Wyant, 624 South Western Ave., Los Angeles, are architects.

Calif., Hollywood—International Medical Societies Ltd., c/o R. D. Frankfurt, 1096 North Western Ave., Los Angeles, Archt., plans the construction of a 12 story office building including steam heating system, elevators, etc.

Calif., Long Beach—E. M., W. and G. Billings, having plans prepared for the construction of a 12 story hotel including steam heating system, elevators, etc. on Ocean Blvd. W. H. Austin, Pacific South Western Bank Bldg., is architect.

Calif., Los Angeles—Childrens' Hospital Assn., is having plans prepared for the construction of a hospital and nurses home including steam heating and refrigeration systems elevators, etc. at Sunset Blvd. and Vermont Ave. Estimated cost $500,000. L. H. Hibbard, Metropolitan Bldg., is architect.

Calif., Los Angeles—Los Angeles County Medical Assn., c/o Parkinson & Parkinson, Title Insurance Bldg., Archts., is having plans prepared for the construction of a 13 story office building at Wilshire Blvd. and West Lake Ave. Estimated cost $1,000,000.

Calif., Los Angeles — W. G. McCarthy, 1412 Wilshire Blvd., will soon award contract for the construction of a 6 story apartment including steam heating system, 4 elevators, etc., at Wilshire Blvd. and Rodeo Dr. Estimated cost $1,250,000. Walker & Eisen, Western Pacific Bldg., are architects.

Calif., Los Angeles—People's Holding Co., c/o Walker & Eisen, Western Pacific Bldg., Archts., plans the construction of a 12 story bank and office building including steam heating system, elevators, etc. on South Hill St. Estimated cost $500,000.

Calif., Los Angeles—E. Small, 6331 Hollywood Blvd. and E. M. Asher, Metro Picture Corp., 1040 North Las Palmas Ave., plan the construction of an apartment on Rossmore Ave. Estimated cost $750,000. Architect not selected.

Calif., Los Angeles—Tosca Investment Co., H. Sugarman, Pres., 1971 North Berendo St., plans the construction of a 12 story hotel at 339 South Figueroa St. Estimated cost $750,000. L. A. Smith, Film Exchange Bldg., is architect.

Calif., Los Angeles—Union Bank & Trust Co., Union Bank Bldg., awarded contract for the construction of a 12 story bank and office building at 8th and Hill Sts. to McNeil Co., 5860 South Park Ave. Estimated cost $500,000. Steam heating plant, elevators, etc. will be installed.

Calif., Mare Island—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 24 for the installation of four 300 hp. water tube boilers, oil burning equipment, etc., in Navy Yard Hospital here.

Calif., Pismo Beach—C. Mabrey, Ochsner Bldg., Sacramento, will build a 6 story hotel and club building here. Estimated cost $1,000,000. Dean & Dean, California State Life Bldg., Sacramento, are architects. Owner is general contractor.

Calif., San Francisco — M. Andresen & C. Byrne, c/o W. L. Schmolle, 519 California St., Archt., are having plans prepared for the construction of two 11 story apartment buildings including steam heating system, electric elevators, etc. at Vallejo and Gough Sts.

Calif., San Francisco—L. B. Ham, et al, 105 Montgomery St., plans the construction of a hotel at Ellis, Stockton and Powell Sts. Estimated cost $1,000,000.

Calif., Santa Monica—Syndicate, E. B. Conliss, 1251 Ocean Ave., plans the construction of a hotel. Estimated cost $1,200,000.

Fla., Monticello—Jefferson County Chamber of Commerce, E. Leach, Temporary Mgr., plans the construction of a cold storage, curing and drying plant consisting of a 10 ton ice plant, 2,000 gal. capacity milk cooling room, 2,000 gal. pasteurizing plant, 20,000 lb. meat cooling room, 20,000 bu. sweet potato storage house, etc.

Fla., St. Petersburg — Florida Mutual Building Inc., Power & Light Bldg., will soon receive bids for the construction of a 20 story bank and office building at 1st Ave. N. Estimated cost $1,800,000. W. N. Smith, 101 Park Ave., New York, N. Y., is architect.

Ill., Chicago—H. De Camp, c/o A. McAnsh, 208 South La Salle St., plans the construction of an 18 story apartment at 5831 Sheridan Rd. Estimated cost $2,000,000. Architect not announced.

Ill., Chicago—Midland Club, 25 East Jackson Blvd., awarded general contract for the construction of a 22 story stores, office and club building at 168-170 West Adams St. to Duffy-Noonan Construction Co., 149 South Dearborn St. Estimated cost $4,000,000.

Ill., Chicago—D. S. Klafter, 64 West Randolph St., Archt., will soon receive bids for the construction of a 16 story office building including oil burning system at Wells and Franklin Sts. for I. M. Mills, 111 West Monroe St. Estimated cost $1,500,000.

Ill., Chicago—The Pressed Steel Car Co., 134 South La Salle St., has retained Thomas E. Murray Inc., 55 Duane St., New York, N. Y. Engrs. to make a complete survey of their power requirements at plant here.

Ill., Chicago—A. G. Rosenfeld, 155 North Clark St., awarded general contract for the construction of a 7 story apartment at 5746 Kenmore Ave. to Reliance Co., 11 South La Salle St. Estimated cost $600,000.

Ill., Chicago — K. Rosenthal, 77 West Washington St., awarded contract for masonry, etc. for a 14 story hotel at Chestnut and Ernst Ct. to A. & E. Anderson, 19 South La Salle St. Estimated cost $1,000,000.

Ill., Chicago—Statler Hotel Corp., 6019 Winthrop Ave., awarded general contract for the construction of a 16 story hotel at 1032 North Dearborn St. to M. Stein, 6019 Winthrop Ave. Estimated cost $1,500,000. Thomas R. Bishop & Son, 35 South Dearborn St., are architects. Oil burning vacuum heating system will be installed.

Ill., Chicago—Syndicate, c/o D. S. Klafter, 64 West Randolph St., Archt., will soon award contract for the construction of a 3 story apartment at 3618 North Marshfield Ave.

Ill., Waukegan—City will receive bids until Dec. 23 for waterworks improvements including filtration plant, pumping station, etc. Estimated cost $950,000. H. A. Allen, 208 North Wells St., Chicago, is engineer. Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., are associate engineers.

Ind., Gary—Ernest A. Barger, plans the construction of a 6 story hotel at Lake Shore and Lake Ave. Estimated cost $1,000,000. L. H. Warriman, is architect.

Ind., Indianapolis—Standard Grocery Co., L. A. Jackson, Pres., 419 East Washington St., awarded contract for the construction of a produce warehouse at Maryland and Shelby Sts. to L. B. Millikan, 501 North Delaware St. Estimated cost $100,000. A large refrigeration plant will be installed.

Ind., Peru—City, H. L. Baltimore, Clk., awarded contract for the construction of an electric light plant to C. Clifton, 231 East River St. Estimated cost $40,000. B. Freeland, is superintendent. 1,000 hp. boiler will be installed.

Ind., South Bend—Coliseum Co. Inc., G. A. Farabaugh, Secy., 304 Union Trust Bldg., is having plans prepared for the construction of a coliseum including an artificial ice skating rink. Estimated cost $400,000. Kervick & Fagan, 208 Poledor St., are architects.

Ia., Grinnell—City, H. B. Lowrey, Clk, will receive bids until Nov. 23 for improvements to sewage disposal plant including 2 in centrifugal pump with gasoline or electric motor, etc. Ralph B. Slippy Engineering Co., Waterloo, is engineer.

Ky., Louisville—U. S. Engineer Office, War Dept., Washington, D. C., will receive bids until Nov. 30 for the construction of a power house at Dams 47 and 51 on the Ohio River here.

Mass., Boston—Metropolitan Realty Co., c/o Desmond & Lord, 1 Beacon St., is having preliminary plans prepared for the construction of a 15 story hotel at Commonwealth Ave. and Bay State Rd. Estimated cost $6,500,000. Engineer not selected.

Mass., Boston—P. O. Box 254, Station A, is in the market for a 15 hp., 110 v., d.c. electric motor and generator.

Mass., Worcester—American Steel & Wire Co., 74 Grove St., will build group of buildings for steel rolling mill including an electric sub-station, etc. Estimated cost $1,000,000. A. F. Backlin, Rockefeller Bldg., Cleveland, O., is engineer. Work will be done by separate contracts.

Mich., Ann Arbor—Industrial Bankers Corp., Industrial Bank, Detroit, plans the construction of a 9 story hotel including steam heating boiler and equipment, elevators, etc., on East Huron St. Estimated cost $1,000,000. Architect not selected.

Mo., Manchester—St. Louis County Ice & Cold Storage Co., 9237 Manchester Ave., is having plans prepared for the construction of an ice and cold storage plant. Estimated cost $40,000.

Mo., New Madrid—City plans an election Nov. 30 to vote $31,000 for the construction of a sewage pumping plant, etc. A. C. Moore, Joplin National Bank Bldg., Joplin, is engineer.

Mo., St. Louis—Local Syndicate c/o Gantz & Early Co., Arcade Bldg., is having preliminary plans prepared for the construction of an 11 story apartment at Delmar and Grand Blvd. Estimated cost $850,000. Manske & Bartling, 410 North Euclid Ave., are architects.

Mo., St. Louis—Water Dept., J. Pritchard, Dir., will receive bids until Dec. 14 for waterworks improvements including superstructures of boiler house, engine house, high and low service pumping pits, etc., at Howard's Beach on the Missouri River. Estimated cost $1,000,000.

N. J., Elizabeth—Chamber of Commerce Corp., A. J. David, Pres., plans the construction of a hotel. Estimated cost $1,500,000. Architect and engineer not selected.

N. J., Hawthorne (Paterson P. O.)—Borough Comrs., J. A. Shea, Clk., will receive bids until Dec. 10 for the construction of a pumping station including pumping equipment, etc. H. J. Harder is engineer.

N. J., Newark—City awarded contract for the construction of a power house to F. Briscoe Co., 287 South 19th St. Estimated cost $156,054.

N. Y., Buffalo—New York Telephone Co., State St., Albany, is having plans prepared for the construction of a 12 story office building on Church St. here. Estimated cost $1,500,000. McKenzie, Voorhies & Gonelim, 34th St. and Madison Ave., New York, are architects.

N. Y., New York—Five Hundred Eighty Five West End Ave. Corp., c/o G. F. Pelham, 570 7th Ave., Archt., is having plans prepared for the construction of a 16 story apartment including 4 electric elevators, etc. Estimated cost $1,250,000.

N. Y., New York—M. Glaser, c/o B. R. Swartburg, 2 West 46th St., Archt., will soon receive bids for the construction of a 15 story apartment including 2 electric elevators, etc. at 41 West 72nd St. Estimated cost $750,000.

N. Y., New York—P. B. La Velle, 505 5th Ave., Archt., is making sketches for the construction of a 20 story apartment on 46th St. Estimated cost $1,000,000. Owner's name withheld.

N. Y., New York—Merchants Square Corp., C. G. Edwards, 90 Franklin St., awarded contract for the construction of a 17 story office and loft building to G. Richard Davis & Co. Inc., 12 East 41st St. Estimated cost $6,000,000.

N. Y., New York—Three Hundred Fifteen West Eightieth St. Corp., c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 15 story apartment at 313-321 West 80th St. Estimated cost $1,000,000.

N. Y., St. George, S. I.—American Trust Co. and New York Title & Mortgage Co., 135 Broadway, New York, will soon receive bids for the construction of a 12 story bank and office building. Estimated cost $750,000. H. S. Luckman, 135 Broadway, New York, is architect.

O., Cincinnati—W. Lucking, Broadway Hotel, plans the construction of a 20 story office building at 5th and Walnut Sts. Estimated cost $1,000,000. H. Hake, Gilbert Ave., is architect.

O., Dayton—Constructing Quartermaster, Wright Field, will receive bids until Nov. 23 for the construction of a pump house with all necessary machinery and equipment, at Wright Field.

Okla., Lawton—Southwestern Light & Power Co., Braniff Bldg., Oklahoma City, Okla., is having plans prepared for the construction of a 100 ton ice plant here. Estimated cost $175,000. Private plans.

Okla., Shawnee—City plans an election Nov. 24 to vote $265,000 bonds for the construction of a waterworks system including 7 deep well pumps and motors, etc. E. T. Archer & Co., 612 New England Bldg., Kansas City, Mo., are engineers.

Pa., Philadelphia—Dept. of City Transit will receive bids until Nov. 23 for the construction of substations 4 and 5 on London and Cumberland Sts., for housing synchronous converters and auxiliary apparatus for furnishing power for operation part of Broad St. subway.

Pa., Pittsburgh—The National Tube Co., Frick Bldg., will soon receive bids for the construction of a research laboratory including steam heating system, two boilers, etc. Estimated cost $150,000. E. Stotz, Monon Bank Bldg., is architect.

S. C., Clarks Hill—Savannah River Electric Power Co., P. S. Arkwright, Pres., Greenwood, subsidiary of Southeastern Power & Light Co., B.-M. Bldg., Birmingham, Ala., and Alabama Power Co., 600 North 18th St., Birmingham, Ala., has filed application with the Federal Power Commission to construct a 120,000 hp. hydro-electric plant on the Savannah River, here, 21 mi. from Augusta, Ga. Estimated cost approximately $20,000,000.

Tenn., Chattanooga — Lookout Mountain Hotel Co., P. Carter, Pres., awarded contract for the construction of a 5 story hotel to Underwood Construction Co., Louisiana Bldg., New Orleans, La. Estimated cost $1,000,000.

Tex., Amarillo—F. W. Frost & Associates, City National Bank Bldg., San Antonio, is having preliminary plans prepared for the construction of a 14 story theatre, bank and office building here. Estimated cost $1,250,000. Architect not selected.

Tex., Cuero—City plans improvements to waterworks including 1,000 g.p.m. centrifugal pumps direct connected to electric motor, tank on tower, etc. Estimated cost $25,000. LeRoy Hamilton, is mayor.

Tex., Ennis—Ennis Ice Co. is receiving bids for machinery for 85 ton ice plant including ammonia compressor, motor, etc. Estimated cost $25,000. J. T. Ludlow, 460 Montgomery St., San Francisco, is engineer.

Tex., Laredo—Aztec Hotel Co. Inc., awarded general contract for the construction of a 10 story hotel at Flores and Grant Sts. to Kelwood Co., Travis Bldg., San Antonio. Estimated cost $425,000. Bids will be received about Dec. 1 for heating plant, water cooling and ventilation systems, elevators, etc.

Tex., Levelland — Texas Utilities Co., Waco, is having preliminary plans prepared for the installation of additional machinery to double the capacity of power plant, also a 15 ton additional ice plant. Estimated cost $40,000. Private plans.

Tex., Llano—Texas Public Utilities Co., Waco, plans the construction of a power dam, 2,500 ft. long and 170 ft. high on the Colorado River near Bluffton, 18 miles from here. Estimated cost approximately $3,000,000. Private plans. Work will be done by owners' forces.

Tex., San Antonio—City Commission, will receive bids until Nov. 22 for the construction of an air conditioning refrigeration plant in auditorium. Estimated cost $25,000. I. Ewig, is city engineer. M. L. Diver, Calcasieu Bldg., San Antonio, is consulting engineer.

Tex., San Antonio—Etherridge Bros., has acquired a site and plans the construction of a hotel and office building on Martin St. Estimated cost $1,000,000.

Tex., San Antonio — San Antonio Turn Verein had plans prepared for the construction of a 10 story club, hotel and theatre building at Nacogdoches and Houston Sts. Estimated cost $1,500,000. L. Harrington & Co., Builders Exchange Bldg., are architects.

Tex., San Antonio — Woods Properties Corp., H. C. Wood, Travis Bldg., will receive bids until Nov. 15 for the construction of a 12 story hotel including 3 elevators, etc., at Mattin and Navarro Sts. Estimated cost $550,000. Kelwood Co., Travis Bldg., is architect and engineer.

Tex., San Benito—Rio Grande Valley Gas Co., c/o J. B. Gaines, is having surveys made for the construction of refrigeration and pre-cooling plants at various points in lower Rio Grande Valley. Private plans.

Wash., Seattle—Bd. of Public Works, accepted plans prepared by F. R. Nicholas, special Skagit engineer working under the direction of J. D. Ross, superintendent of Seattle's municipal lighting department for a dam at Diablo Canyon which will afford 100,000 acre ft. water storage space in connection with the Skagit River hydro-electric power development. Following completion of this work, a power plant will be built and bids taken for furnishing two 37,500 hp. turbines, transformers, switching equipment, etc., plant and equipment to develop 75,000 hp. will cost $2,689,500. Total cost including railroad, dam, equipment, etc. $6,089,500. Specifications for equipment will be written after first of year.

Wash., Seattle—L. N. Rosenbaum, c/o Pretica & Peters, Pantages Bldg., Archts., plans the construction of a 12 story apartment at Terry Ave. and Pine St. Estimated cost $1,000,000.

Wis., Milwaukee—National Layton Improvement Co. c/o Dick & Bauer, 208 3rd St., Archts., is having plans prepared for the construction of a theatre and office building on National Ave. Estimated cost $700,000.

Ont., London — Hygrade Corrugated Products, Ltd., C. Munce, Mgr., 699 Bathhurst St., awarded contract for the construction of a factory and boiler house on Adelaide St., to S. Foxworth, 616 Waterloo St. Estimated cost $85,000. Owner is in the market for boilers and radiation, etc.

Ont., Toronto—Central Sites Development Co., Bloor & Bay Sts., plans the construction of a 12 story office building including steam heating system, elevators, etc., at Bloor and West Balmuto Sts. Estimated cost $1,000,000. F. G. Engholm, 56 Huntley St., is engineer.

Que., Montreal—Montreal Rail & Harbor Terminal Ltd., 34 King St., Toronto, Ont., awarded contract for the construction of a 10 story warehouse and cold storage plant to Park-Lap Inc., Toronto, Ont. Estimated cost $5,000,000.

Mexico, Michoacan—Mexican Light & Power Co., Gante St., Mexico City, is having plans prepared for the construction of a hydro-electric plant on the Lerma River here. Estimated cost approximately $3,000,000.